QE21
A1
C3
78th
S
S

PHYSICAL SCIENCES
LIBRARY
UC DAVIS

seventy-eighth report of the state geologist (1985-1986)

1416 Ninth Street
Sacramento, CA 95814

UNIVERSITY OF CALIFORNIA
DAVIS
APR 29 1988
CALIF. DEPOS.
GOVT. DOCS. - LIBRARY

THE RESOURCES AGENCY
GORDON K. VAN VLECK
SECRETARY FOR RESOURCES

STATE OF CALIFORNIA
GEORGE DEUKMEJIAN
GOVERNOR

DEPARTMENT OF CONSERVATION
RANDALL M. WARD
DIRECTOR

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS
STATE GEOLOGIST

SEVENTY-EIGHTH REPORT OF THE STATE GEOLOGIST

ACTIVITIES OF THE CALIFORNIA DIVISION OF MINES AND GEOLOGY JULY 1, 1985 THROUGH JUNE 30, 1986

James F. Davis, State Geologist
California Department of Conservation
Division of Mines and Geology
1416 Ninth Street
Sacramento, CA 95814

FOREWORD

The responsibilities of the Department of Conservation's Division of Mines and Geology (DMG) can be considered to be in three categories: Investigative studies, advisory services and information dissemination. Investigations of mineral resources and geologic hazards provide the basis for advisory services to sister State agencies and local governments in a wide variety of circumstances ranging from earthquake prediction evaluation to the geologic context of local government land-use decisions and policies. Information is disseminated to users in general through publications of the observations and conclusions derived from the investigative studies.

During fiscal year 1985-86, several notable developments took place. DMG undertook a new responsibility, the collaboration with the U.S. Geological Survey in an effort to predict a Magnitude 6 earthquake in the Parkfield area of the San Andreas fault midway between Los Angeles and San Francisco. Also the reclamation element of the Surface Mining and Reclamation Act (SMARA) program was returned to the former staffing and funding level it had achieved prior to fiscal year 1984-85.

The report which follows chronicles the major accomplishments of 1985-86 in all of the programs of the Division.

CONTENTS

Page

FOREWORD..... iii

DIVISION PROGRAMS..... 1

I. Mineral Land Classification and Reclamation Program 3
1. Urban mineral land classification..... 4
2. Country mineral land classification..... 7
3. Mined land reclamation..... 10

II. Geologic Hazards Program..... 13
1. Landslides hazard identification studies..... 13
2. Fault studies..... 14
3. Marine geology studies..... 15
4. Cooperative studies with county and local governments..... 17
5. Special investigations..... 18

III. Geophysics Program..... 19
1. Earthquake hazard and risk assessment..... 19
a. Damage scenarios..... 19
b. Seismic hazard maps..... 20
c. Seismic monitoring..... 21
d. Volcanic hazard monitoring..... 21
e. Southern California Seismic Project..... 21
f. Advisory services..... 22
2. Strong Motion Instrumentation Program..... 22

IV. Mined Resource Assessment Program..... 27
1. Geological studies..... 27
a. Mineral commodity reports..... 27
b. Current mining activities..... 27
c. Review of possible land withdrawals from mineral entry..... 27
d. Special geological priority projects..... 28
2. Geochemical studies..... 28
3. Geophysical support studies..... 28
a. Gravity mapping..... 28
b. Aeromagnetic mapping..... 29
c. Geophysical projects to support other investigations..... 29
d. Geothermal resource studies..... 30

CONTENTS (Continued)

Page

V. Geologic Investigations Program..... 31

1. Fault evaluation and zoning..... 31
2. Regional geologic mapping..... 35
3. Timber harvest plan review..... 36

VI. Geologic Information Program..... 39

1. Information service and publications sales..... 39
2. Publications production..... 39
3. Geology library..... 40
4. Critical-siting report review..... 40
   a. Environmental impact report reviews..... 40
   b. Hospital site report reviews..... 40

APPENDIX I. Publications Released during 1985-86..... 43

FIGURES

		Page
Figure 1.	Status of the Urban SMARA Classification-Designation Program.....	5
Figure 2.	Status of Country SMARA mineral land classification projects in the California Desert Conservation Area.....	8
Figure 3.	Status of Country SMARA mineral land classification projects in the Sierra Nevada foothills region.....	9
Figure 4.	Map sheets in the California Continental Margin Map series.....	16
Figure 5.	Stations of the Strong Motion Instrumentation Program, June 30, 1986.....	25
Figure 6.	Strong-motion records from the Redlands earthquake of October 2, 1985.....	26
Figure 7.	Principal faults in California zoned for special studies under the Alquist-Priolo Act of 1972.....	32
Figure 8.	New and revised Special Studies Zones maps released on July 1, 1986.....	34
Figure 9.	Status of the Regional Geologic Mapping Program.....	37

TABLE

Table 1.	Facilities instrumented by SMIP during 1985-86	24

DIVISION PROGRAMS

The California Department of Conservation's Division of Mines and Geology (DMG) is the state geological survey of California. As such, its primary function is to provide technical data to assist public agencies and the private sector in the wise and safe use of the earth's crust, its terrain, and its mineral resources. The broad objectives of the Division are: (1) to identify, delineate, and assist in the ultimate utilization of deposits of minerals, both onshore and offshore, consistent with wise conservation practices; (2) to identify and provide timely delineation of geologic hazards; and (3) to compile and, where needed, develop basic data on the geology of the state in support of geologic hazard and mineral resource investigations.

To achieve these broad objectives, the Division carries out a wide range of activities through six basic programs. These are: (1) the Mineral Land Classification and Reclamation Program, (2) the Geologic Hazards Program, (3) the Geophysics Program, (4) the Mined Resource Assessment Program, (5) the Geological Investigations Program, and (6) the Geologic Information Program. These six programs and their activities during fiscal year 1985-86 are described in the following pages.

Overview

MINERAL LAND CLASSIFICATION AND RECLAMATION PROGRAM (SMARA)

The Mineral Land Classification and Reclamation Program conducts investigations of mineral deposits and geologic terranes to provide public information on the extent, nature, and magnitude of the state's mineral resources. The goal of the program is to help the people of California and the nation meet future mineral needs and to assist in efforts to assure that mined lands are adequately reclaimed. The program's classification of mineral lands according to the significance of the mineral deposits and the assistance it provides in mined land reclamation are used in land-use planning and regulatory programs administered by local government as well as by private industry. Specific areas of program activity are (1) urban mineral land classification, (2) country mineral land classification, and (3) mined land reclamation.

GEOLOGIC HAZARDS PROGRAM

The Geologic Hazards Program provides information on geologic hazards, including landsliding, ground rupturing caused by fault movements, ground shaking caused by earthquakes, tsunamis (seismic sea waves), volcanic eruptions, land subsidence, expansive soils, and erosion. The information ranges in use from technical to lay applications. Areas of potential geologic hazard are delineated for land-use and emergency-response planning applications. Specific areas of program activity are (1) landslide hazard identification studies, (2) fault studies, (3) marine geology studies, (4) cooperative studies (under cost-sharing agreements) with local government or other State agencies to identify geologic hazards, and (5) as-needed special investigations of dynamic geologic events and conditions that may have immediate effects on man such as damaging earthquakes or slope failures during storms.

GEOPHYSICS PROGRAM

The Geophysics Program provides specialized earth science expertise for assessing and mitigating volcanic, seismic, and other geologic hazards. This expertise is essential for evaluation of the seismic safety of critical and hazardous facilities and as input for the development of emergency-response plans and the design of earthquake-resistant structures. Specific areas of program activity are (1) earthquake hazard risk assessment, including volcanic hazard monitoring, and (2) strong-motion instrumentation program.

MINED RESOURCE ASSESSMENT PROGRAM

The Mined Resource Assessment Program implements the State Mining and Minerals Policy (Public Resources Code Section 2650) by developing a variety of data concerning mineral resources that can be used to foster and encourage private enterprise in the industries, the orderly and economic exploration, development, and utilization of the State's mineral resources, and mining, mineral, and metallurgical research to promote the wise and efficient use of natural and reclaimable mineral resources. This information includes data on current mining activities, mineral production statistics, mineral commodity reports, review of possible public land withdrawals from mineral entry, development of geochemical and geophysical data, and applied geophysics support of other Division programs.

GEOLOGIC INVESTIGATIONS PROGRAM

The Geologic Investigations Program provides both basic and applied geologic information--primarily, but not solely, in the form of maps. This information is used in mineral resource development, in land-use planning and regulation by local government, in timber harvest planning, in development-site evaluation studies, and in other endeavors requiring sound information on the geology of the state. Specific areas of program activity are (1) fault evaluation and zoning, (2) regional geologic mapping, and (3) timber harvest plan review.

GEOLOGIC INFORMATION PROGRAM

The Geologic Information Program makes information prepared by Division program activities and other pertinent geologic information available to the general public, including local government, the scientific community, and the public at large. The products of Division investigations are edited and graphically prepared for printing. The program also provides technical review of siting reports for certain proposed developments within the state. Specific areas of program activity are (1) information and publications sales, (2) publications production, (3) geology library, and (4) critical-siting report review.

I. Mineral Land Classification and Reclamation Program (SMARA)

DMG's Mineral Land Classification and Reclamation Program was established to carry out the intentions of the Surface Mining and Reclamation Act (SMARA) of 1975. The objectives of this legislation are to stimulate the wise use of lands containing mineral resources that are critical to the economy of California and also to provide for State assistance in planning for the reclamation of surface-mined lands. These objectives are reached through land-use planning and regulatory programs administered by local government. The California Department of Conservation, Division of Mines and Geology, and the State Mining and Geology Board are responsible for administering the State's role in SMARA programs.

Staff of the Mineral Land Classification and Reclamation Program conduct geologic investigations of mineral deposits, assess the mineral potential of specific areas, and provide assistance to local governments and industry in planning for surface mining and reclamation of mined lands. Information generated through these activities is published in special reports, maps, and open-file reports. Specific advice is available through direct consultation with program staff.

In developing this information, program staff interpret data in light of an understanding of mineralization and other complex geologic processes, all of which are conditioned by the extreme complexity of California's geology. This complexity is largely attributable to the state's position at the edge of the continent where one major plate of the earth's crust converges with another major plate. The ongoing interaction between these tectonic plates has enlarged the continent and resulted in volcanism, the formation of mountain ranges, major displacements of land masses along faults over time (through periodic earthquakes and deformation), and numerous other dramatic as well as subtle geologic developments that are responsible for the abundance and diversity of mineral occurrences in California.

California is the nation's leading producers of non-fuel minerals. The agricultural, manufacturing, and construction industries of the state are supplied by numerous mineral commodities produced by the mining industry of California. Approximately $2.0 billion in non-fuel mineral commodities were produced in the state during 1985. California leads the nation in production of boron, portland cement, diatomite, sand and gravel, and rare earth's. It is also a major source of natural gas, liquefied petroleum gases, salt, clay, stone, magnesium compounds, sodium compounds, gypsum, and talc. In addition, California has within its boundaries a wide range of recognized but undeveloped mineral resources. These include chromium, cobalt, gold, mercury, nickel, platinum group elements (PGEs), silver, titanium, and zeolites. Some of these are of strategic importance to the nation.

DMG's Mineral Land Classification and Reclamation Program carries out the intentions of SMARA through three interrelated units: the Urban Mineral Land Classification unit, the Country Mineral Land Classification unit, and the Mined Land Reclamation unit. These units represent a cost-effective means of ensuring that California's mining industry continues to provide society with needed mineral commodities in an environmentally sensitive manner.

1. Urban mineral-land classification (element of SMARA)

The current objective of urban mineral-land classification ("City SMARA") is the identification of lands that contain suitable and available aggregate materials (sand and gravel, and rock suitable for crushing) to meet future local and regional needs. This objective is achieved through a mineral inventory and economic assessment process termed "classification-designation," which jointly involves the Division and the State Mining and Geology Board. Information on the location of important mineral deposits is developed by the Division through the process of mineral-land classification. This information is evaluated by the Board, whose prerogative it is to designate those resources that are yet available and of economic significance to a region or the state. Local governments receive the classification-designation information, incorporate it in their general plans, and develop mineral resource management policies that will assure the conservation and development of these resources.

Although DMG is involved primarily in the classification phase of classification-designation, an understanding of designation is needed to understand the role of classification in the overall process.

Designation is a formal action taken by the State Mining and Geology Board. Designation of an area means that, in the judgment of the Board, the minerals in that area are of prime importance for meeting the future mineral needs of the region or the state. The process apprises local governments of a responsibility in their planning activities to provide not only for their local needs but also for the needs that may be generated well outside their own areas of jurisdiction.

The Board has given first priority to the designation of construction aggregate deposits of Portland-cement-concrete (PCC-grade) in urban and urbanizing areas. The Board's decision to designate particular areas is based on information in mineral land classification reports and environmental assessments and reviews prepared by DMG, and on input from lead agencies and the public.

As noted above, DMG is primarily responsible for carrying out the classification phase of the classification-designation process. Classification normally entails six distinct but interrelated steps. These classification steps will be explained here in the context of the classification for PCC-grade aggregate.

The first step in the classification process is to determine the boundaries of the production-consumption (P-C) region under study. The boundaries are drawn along the limits of the marketing area of the active aggregate operations supplying the urban center under study. Included within the production-consumption region boundaries are all areas within the marketing area that have been identified as urbanized or urbanizing.

In step two, all lands considered to be urbanized or urbanizing are assigned Mineral Resource Zone classifications (MRZ-1--no significant deposits present; MRZ-2--significant deposits present; MRZ-3--insufficient data to determine significance of deposits; MRZ-4--insufficient data to identify deposits) based upon a geologic appraisal of the aggregate resource potential of the land. This appraisal includes study of pertinent geologic reports and maps, field investigation and sampling at outcrops and at active and inactive pits and quarries, and analysis of water-well logs and drill records.

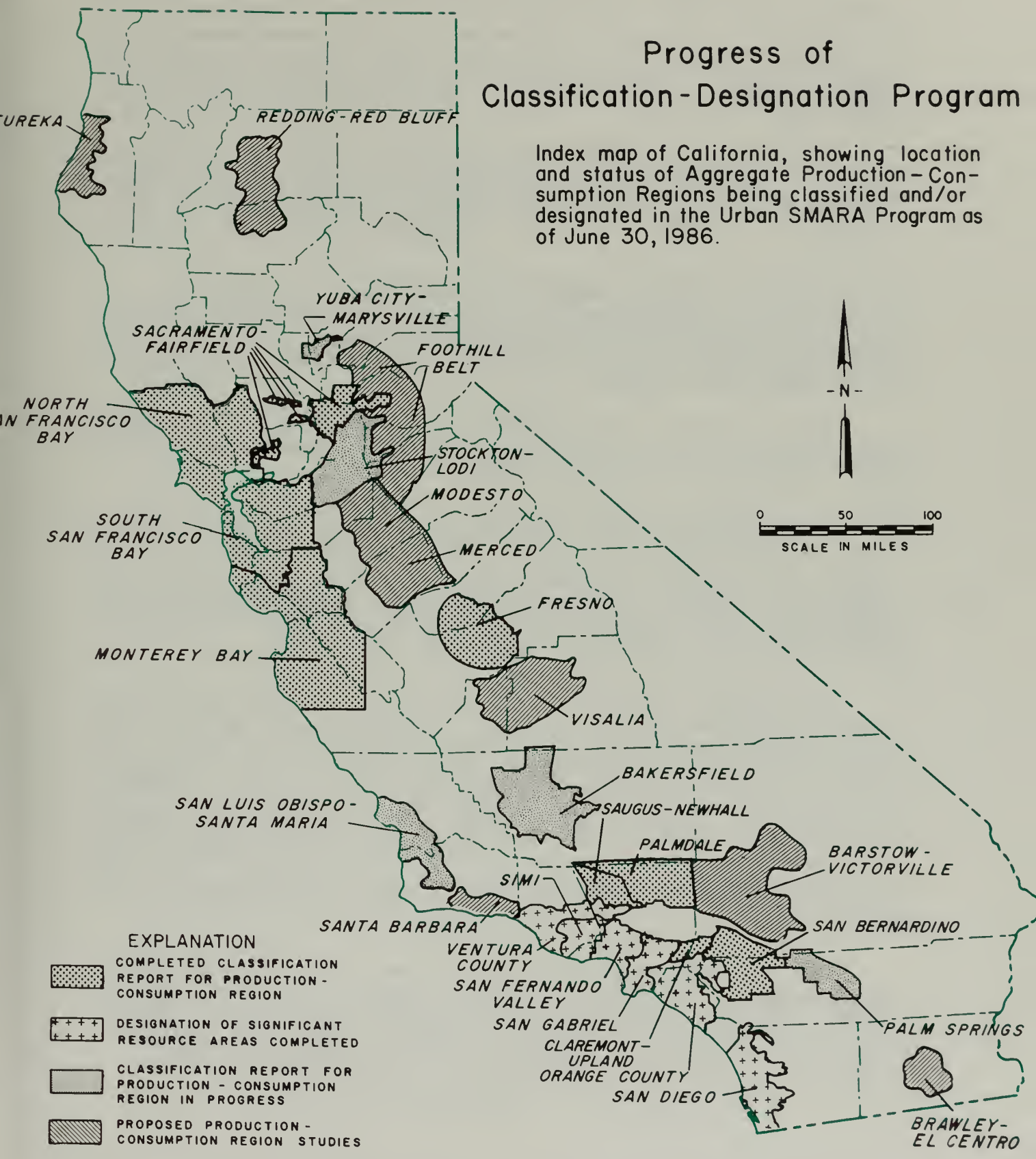


Figure 1. Status of the Urban SMARA Classification Designation Program, June 30, 1986.

In step three, lands classified as containing significant deposits of PCC-grade aggregate material (areas classified MRZ-2) are evaluated to determine whether or not current uses of these lands preclude possible future mining. Areas currently permitted for mining and areas found to have land uses compatible with possible future mining--based on criteria provided by the Board--are considered available for mining, and are delineated as "sectors"--that is, available aggregate source areas.

In step four, for each sector, total tonnages of PCC-grade aggregate reserves (deposits permitted for mining) and resources (all deposits of PCC quality including the reserves) are calculated based upon field investigation and surface measurement, drill-hole information, waste-material percentages, and deposit densities.

In step five, 50-year needs of the production-consumption region are estimated based upon population growth projections and average annual per capita aggregate consumption rates. Based upon these calculations, the life expectancy of current reserves is estimated, and projected needs are analyzed in relation to current reserves and resources.

Step six involves the identification and characterization of possible alternative sources for PCC-grade aggregate needed to meet the forecasted 50-year demand for the production-consumption region.

CLASSIFICATION. Figure 1 shows areas classified or designated, and areas under classification study as of June 30, 1986. During the year the City SMARA program completed the Fresno mineral-land classification report and transmitted the results to the Board for its acceptance. Studies in progress during 1985-86 included the Yuba City-Marysville, the Bakersfield, the Stockton-Lodi, the Palm Springs, and the San Luis Obispo production-consumption regions.

DESIGNATION. Designations of regionally significant mineral resources have been completed in the San Fernando Valley, Simi Valley, Western Ventura County, Orange County-Temescal Valley, San Gabriel Western, and San Diego County production-consumption regions (see Figure 1). In 1985-86, no new designations were completed, but work on seven production-consumption (P-C) regions was well underway. These P-C regions include Claremont-Upland, San Bernardino, Saugus-Newhall, Palmdale, North San Francisco Bay, South San Francisco Bay, and Monterey Bay. They are scheduled for completion early in 1986-87. For additional information on designation, see the "Annual Report of the State Mining and Geology Board."

EIRs. In 1985-86, the DMG urban mineral land classification staff prepared and completed environmental impact reports for the following production-consumption regions: San Francisco Bay, Saugus-Newhall/ Palmdale, and Claremont-Upland/San Bernardino. These documents were prepared in anticipation of Board action to designate certain areas within these regions.

2. Country mineral-land classification (2nd element of SMARA)

The amendment of SMARA in 1980 by the passage of Senate Bill 1300 provided for the mineral-land classification of non-urban ("country") areas requested by the State Mining and Geology Board. In the hearings that preceded the passage of SB 1300, it was made clear by the Legislature that mineral-land in non-urban areas subject to land-use threats incompatible with mining was to be classified. The Board in 1982 assigned the highest priority for the "Country SMARA" program to the foothills region of the Sierra Nevada and the California Desert Conservation Area (Figures 2 and 3). These are two of the most highly mineralized areas in the state and are known to contain mineral deposits of regional and statewide significance.

To achieve the mineral-land classification of these areas, each classification project was structured into three phases: (1) assembly and evaluation of existing geologic, geophysical, and mining data pertaining to each 15-minute quadrangle study area; (2) geologic field investigations, mine examinations, and geochemical surveys; and (3) preparation of a geologic report and mineral resource classification map of the area based upon a synthesis and analysis of data gathered during phases 1 and 2 of the project.

Country SMARA mineral-land classification field activity continued during 1985-86 in the foothills portion of the Sierra Nevada and in the California Desert Conservation Area. Figures 2 and 3 show the areas of coverage for "Country SMARA" studies planned, in progress, and completed, as well as the June 30, 1986 status of the reports covering those areas.

Mineral land classification reports for three areas located in the California desert, representing all or portions of seven 15' quadrangles, were released (Figure 2). These are the Mid Hills (OFR 85-8LA), the Ivanpah-Crescent Peak-Searchlight (OFR 85-7LA), and the Lanfair Valley-Homer Mountain-Davis Dam (OFR 84-LA) quadrangle areas. They address several areas where mineral resources of statewide or regional significance have been identified.

Mineral land classification reports have also been completed, but not released, for three additional areas of the California desert. They represent all or portions of thirteen 15' quadrangles. Reports were in preparation at year's end for all or portions of six 15' quadrangles located in the southeastern desert region. Field work continued in both the northern and southern desert regions for all or portions of 14 more quadrangles.

Mineral land classification reports were being prepared for three quadrangle areas in the Sierra Nevada (Figure 3): Camino, Mokelumne Hill, and San Andreas. Elsewhere, field work was in progress in the Valley Springs quadrangle area of the Sierra Nevada.

Staff geologists were called upon by local government in the Sierra Nevada to testify on mineral resource issues that relate to land-use planning. The Division was also called upon by the U.S. Bureau of Land Management to provide mineral land classification data for nine quadrangle areas located in the California desert. The information was presented at a meeting in Victorville in which the Bureau displayed the mineral survey data at a public gathering.

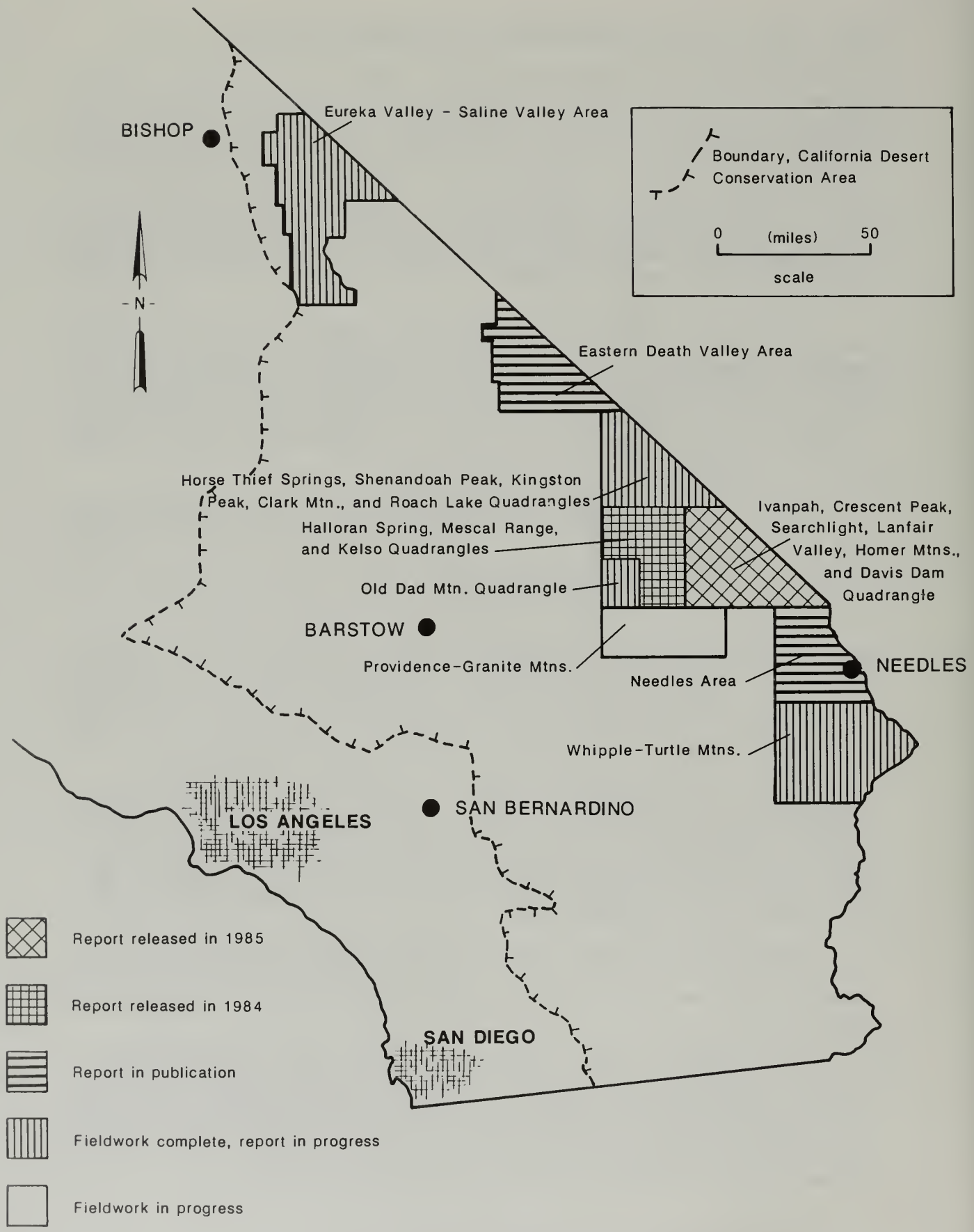


Figure 2. Project status for Country SMARA mineral land classification study areas in the California Desert Conservation Area.

Figure 3. Project status for Country SMARA mineral land classification study areas (15-minute quadrangles) in the Sierra Nevada metamorphic belt.

Several exploration companies showed an interest in technical information gathered from the mineral land classification studies. The data from the mineral surveys was discussed with a number of exploration planners to help identify promising areas for mineral discovery and development opportunities.

Petition Classification. When known mineral deposits are subject to imminent threats which would preclude the extraction of those minerals, the owner of the property may petition the State Mining and Geology Board to have the area of the deposit classified on a high priority basis. The petition process has been helpful to the mineral industry and lead agencies confronted with the need to obtain authoritative, unbiased mineral information prior to reaching difficult decisions on controversial land-use issues. During 1985-86, three petition reports were completed. These were for (1) an area of gold mineralization located near Sonora, (2) a shale/clay deposit located near Colfax, and (3) a limestone deposit near Lucerne Valley.

3. Mined-land reclamation (3rd element of SMARA)

The Mined Land Reclamation Program is the third of three equally important programs established in the Division of Mines and Geology to fulfill the mandates of the Surface Mining and Reclamation Act (SMARA) of 1975. Under SMARA, the reclamation of mineral lands is to be accomplished under the policies and regulations developed by the State Mining and Geology Board (SMGB). Local governments, known as lead agencies, have the responsibility to develop and administer ordinances conforming to the SMGB requirements under the land-use permitting process. Reclamation plans are required to be approved by counties or municipalities as part of the procedures. The reclamation plans are prepared by the mine operator and submitted to the lead agency for approval.

The Division of Mines and Geology, through its Mined Land Reclamation Program, provides both lead agencies and mine operators with technical assistance for the preparation, regulatory review, and implementation of reclamation plans.

The requirements for a complete reclamation plan are presented in Article 5, Sections 2770 through 2779 of SMARA, and in the California Administrative Code (CAC), Title 14, Chapter 8, Subchapter 1, Article 1, Sections 3500 through 3505. Section 2774(c) of SMARA states that "on request of a lead agency, the State Geologist shall furnish technical assistance in the review of the reclamation plans."

Reclamation plans contain the proposed land treatment that minimizes adverse effects from mining operations such as water degradation, damage to aquatic or wildlife habitat, flooding, erosion, and air pollution. The methods used to treat the mined land should result in reclaimed land which is readily adaptable to alternate uses and creates no danger to public health or safety. The land treatments may include revegetation, resoiling, backfilling, grading, soil compaction, stabilization, erosion control, or other measures.

During 1985-86, the Mined Land Reclamation Program accomplished the following:

- Program staff reviewed 140 reclamation documents and provided technical assistance to a variety of lead agencies. Of these, approximately 101 were reclamation plans requiring extensive reviews by reclamation staff.

- Program staff visited approximately 18 mine sites to provide hands-on assistance to lead agencies.

- A series of five workshops was held in May and June of 1986. The workshops were jointly sponsored by the Department of Conservation and the SMGB. Each workshop was held in a different location in the state to reduce travel costs for attendees and provide discussion on problems unique to the location in the state. The workshops were well received and attended by federal, State, and local government representatives as well as representatives of private industry.

  The results of the workshops identified the needs of the attendees and provided insights on how the reclamation staff can provide technical assistance to meet those needs.

- The staff continued to work on a series of publications which will provide useful reclamation information to lead agencies and mine operators. The publications are: Revegetation, Land Shaping, Hydrology, a Bibliography of reclamation reference publications and a Glossary of reclamation terms. The chapters are being reviewed by outside specialists. Publication is pending completion of these reviews and final revision.

II. Geologic Hazards Program

The Geologic Hazards Program provides geologic information--in the form of maps and interpretive texts--about geologic hazards in the state. The products present both technical and lay information useful and necessary for public safety purposes. The information is provided in the form of geologic reports and maps resulting from specialized studies of specific hazards. It is best to identify, if possible, potentially hazardous geologic conditions prior to land development. Hazardous geologic conditions need to be recognized so that action can be taken to prevent the property losses, injuries, or even deaths that they might cause. Geologic hazards include landsliding, ground rupturing caused by fault movements, ground shaking caused by earthquakes, tsunamis (seismic sea waves), volcanic eruptions, land subsidence, expansive soils, and the effects of erosion. Knowledge of potential geologic hazards is critical to the land-use planning process.

Activities directly within the Geologic Hazards Program are: (1) landslide studies; (2) fault studies; (3) marine geology studies; (4) cooperative studies (under cost-sharing agreements) with local government or other State agencies to identify geologic hazards; and (5) special emergency investigations of occurrences such as slope failures during storms and earthquake events. Typical products range from county-wide, comprehensive investigations of all geologic hazards present to large-scale quadrangle mapping which emphasizes slope-stability, erosion, faulting, expansible soil, or other conditions that could become hazards to public safety or lead to property damage.

1. Landslide studies

a. Landslide hazard identification program

In recognition of serious and widespread landslide hazards within the state, the Landslide Hazard Identification Act (Assembly Bill 101, Moore, 1983) established within the Division of Mines and Geology the Landslide Hazard Identification Program. The program is charged with developing maps of landslide hazards in urban and urbanizing areas of the state.

During 1985-86, five Landslide Hazard Identification Maps (LHIMs) totaling 177 square miles that were completed in preliminary form the previous year were revised and prepared for Open-File Report release. The maps include: (LHIM #1) Petaluma "Dairy Belt," Sonoma County, OFR 86-6 LA; (LHIM #3) Danville-San Ramon, Contra Costa County, OFR 86-7 SF; (LHIM #4) Encinitas Quadrangle, San Diego County, OFR 8 LA; and (LHIM #5) E/2 Val Verde Quadrangle, Los Angeles County, OFR 86-9 LA. Each LHIM consists of a series of 1:24,000-scale maps that includes: Plate A - Relative Landslide Susceptibility Map; Plate B - Landslides and Related Features Map; Plate C - Geologic Map; and (in some cases) Plate D - Relative Debris-Flow Susceptibility Map.

The project areas for 1985-86 and scheduled dates for completion of preliminary maps include: E/2 Newhall Quadrangle, Los Angeles County, June 30, 1986; Rancho Santa Fe Quadrangle, San Diego County, June 30, 1986; Benecia-Vallejo, Solano County, September 15, 1986; and SE/4 Whitaker Peak Quadrangle, Los Angeles County, September 15, 1986.

During the summer of 1985, copies of the preliminary maps were distributed for review and, in cooperation with the Mining and Geology Board, a workshop was held at Davis in August to review the first set of maps from the program. To assure fairness in the selection of future project areas, the State Geologist sent a letter to nearly 400 officials (including all planning departments in the state) inviting them to nominate landslide mapping areas. Several dozen candidate areas were proposed and have been prioritized in terms of the critieria specified by AB 101.

b. Other Landslide studies (Prior to Landslide Hazard Identification Program)

Two studies of landslides and related slope failures in southern California, products of the program of financial cooperation between the Division and the U.S. Geological Survey to inventory landslides in selected areas of southern California, are nearing completion for open-file reports. One is a report comparing slope failure and rainfall amounts of the 1983 rains; the other is an inventory of recent slope failures in the Topanga and Canoga Park quadrangles in Los Angeles County.

Two additional studies of landslides in southern California are being prepared for publication as special reports: a detailed report on 1978 and 1980 slope failures in southern California and a report on "Areal Geology, Ancient Landslides, and Recent Slope Failures of the North-Central Coastal area, San Diego County, California."

2. Fault studies

Fault mechanism studies underway during the period of this report include work on the San Gabriel fault, the Hayward fault, and faults in San Diego and Imperial counties. Additional work was done on a continuing study of the general characteristics, recency of movement, and potential for future activity of the San Gabriel fault zone. Field work to study soil development and displacement along the Hayward fault was continued. Information on the San Diego-Oceanside to Salton Sea-El Centro area, including analyses of aerial photos and compilation of data emphasizing fault activity and Quaternary tectonics, was released in 1984-85 as OFR 84-59 LA, "Preliminary Geologic Map of the California-Baja California Border." This year field checking of faults and suspected fault features visible on aerial photos was completed in selected areas north of the U.S.-Mexico border.

A study entitled "The Rose Canyon Fault Zone--a Review and Analysis" was completed in 1984-85 for the Federal Emergency Management Agency (FEMA) under a cooperative financial agreement. Revisions needed prior to release of this study as an open-file report have not been completed.

3. Marine geology studies

The Division's marine geologist completed a major synthesis of offshore California geology. This fiscal year was the sixth year of his work preparing a geologic synthesis of the California continental margin. The resulting maps depict bedrock and surficial geology as well as character and recency of faulting, landslides, sediment creep, sediment conduits, Bouguer gravity anomalies, magnetic anomalies, earthquake epicenters, selected focal mechanisms, data sources, oil and gas well locations, and geophysical track lines. They are compiled at a scale of 1:250,000 on NOS bathymetric bases. The maps will be accompanied by a comprehensive bibliography of geological and geophysical studies conducted within this area as well as by an explanation of symbology, developed largely during this study, that uses example seismic data as a reference for the user. The first part of the study to be released (areas one, two, and three of seven) includes the southern California continental margin from Mexico to Palos Verdes and from the shoreline to the Patton Escarpment. Areas four, five, six, and seven (of seven) cover offshore areas of central and northern California, and are currently being prepared for publication. All seven areas (Figure 4) and the explanatory Bulletin (B 207) were in press at year's end.

The Division's marine geologist continued in the interpretation of high resolution data and processing for selected areas of the California continental margin where detailed information is necessary to shed light upon specific questions that have arisen from our regional geologic synthesis.

The offshore California geologic synthesis was conducted by the Division as a cooperatively funded project between the Coastal Commission, the U.S. Geological Survey, and the Department of Conservation's Division of Mines and Geology. In addition, grant funding from the University of Texas, Austin, has helped in completing this project in a timely way.

Marine geology studies underway during 1985-86 included:

1. Geologic synthesis of the southern California continental margin;

2. Structural transect, Salton Trough to Patton Escarpment;

3. Publication processing of California continental margin geologic maps series.

4. Initial studies of hard mineral occurrences offshore of California (project recessed).

Marine geology studies published during 1985-86 included:

1. Earthquake related hazards in the offshore Los Angeles basin (published in U.S. Geological Survey Professional Paper 1360, p. 347-373, "Identifying Potentially Active Faults and Unstable Slopes Offshore," by S.H. Clarke, H.G. Greene, and M.P. Kennedy).

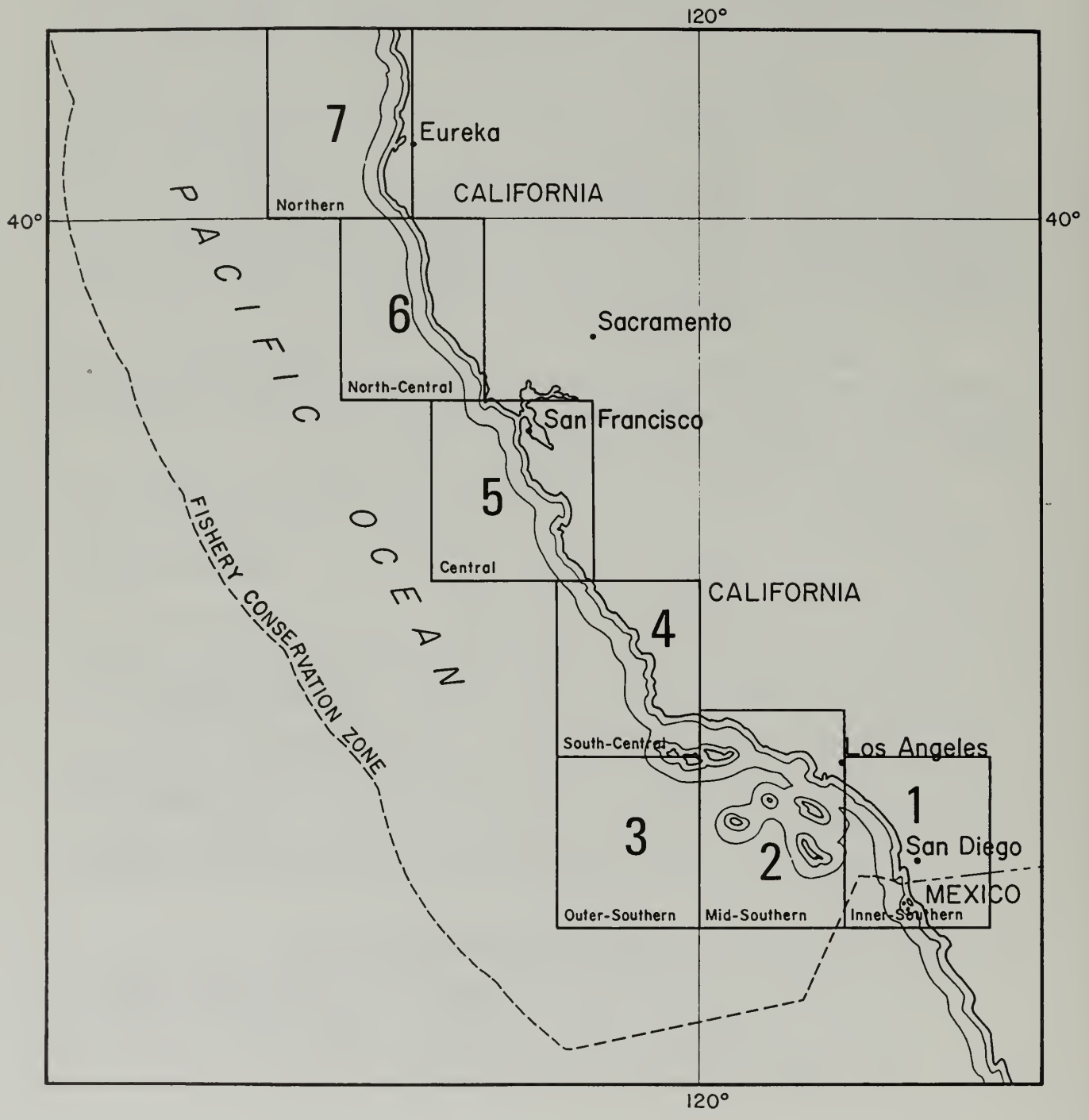


Figure 4. Map sheets in the California Continental Margin Map series.

2. Report of DSRV ALVIN observations (published as U.S. Geological Survey Open-File Report 85-39, "Observations from DSRV ALVIN of Quaternary faulting on the Southern California Continental Margin." Also released as Scripps Institution of Oceanography Special Contribution).

The Marine Geology Program was integrated with the Regional Geological Mapping Program in December 1985. In the future, program reports on Marine geology studies will appear under Regional Geologic Mapping.

4. Cooperative studies with other government agencies

The Division conducts a number of geological studies in cooperation with local government and other State agencies to provide needed technical information about areas of actual or potential geologic hazard. Cooperative activities are funded jointly by the Division and the cooperating agency under various arrangements, the nature of which depends upon the availability of funds and personnel, the relative urgency of the project to the State and to the cooperating agencies, and other factors. Cooperative activities with counties were either suspended or reduced owing to the changed budgetary conditions of both counties and the State after July 1, 1978.

a. Los Angeles County

Cooperative funding by the Los Angeles County Flood Control District terminated at the close of the 1983-84 fiscal year as planned. However, work continued to complete the Division's geologic studies in Los Angeles County initiated under previous funding arrangements with the County of Los Angeles, Department of County Engineer, and with the Los Angeles County Flood Control District. A report on part of the Pasadena quadrangle was revised and nearly completed for open-file release. A geologic map of the north half of the Mint Canyon quadrangle was submitted for open-file release. Field mapping of the southeast quarter of the Newhall quadrangle was nearly complete.

b. Orange County

All projects initiated and well-advanced under previous cooperative funding arrangements with Orange County have been completed and released as Open-File reports. Processing of some of these reports for publication is continuing.

c. California Coastal Commission (see Marine Geology Studies, page 13)

5. Special investigations

Division geologists respond as needed to evaluate the hazard potential of ongoing geologic events. These evaluations are made on the Division's initiative, or at the request of the State Office of Emergency Services or local government. Examples of such investigations during 1985-86 include:

a. Landslide Program staff assessed the potential for debris flows and "mudslides" in areas affected by the major wildfires of 1985 at the request of the Governor's Office of Emergency Services. Predictive maps were distributed to local officials before winter rains to help them plan for evacuation from threatened areas. DMG Note 33, "Hazards from 'Mudslides'...Debris Avalanches and Debris Flows in Hillside and Wildfire Areas," was prepared by program staff to inform the public about these potentially dangerous forms of slope failure.

b. A report describing the activities of the Department of Conservation's Division of Mines and Geology in the area of landslide hazard mitigation was prepared and submitted to the Governor's Office of Emergency Services for inclusion in the State Hazard Mitigation Plan to be submitted to FEMA.

c. The Division continued to participate on the Geologic Technical Committee assembled by the City of Los Angeles following the "Fairfax-Wilshire gas incursion" that occurred on March 24, 1985.

III. Geophysics Program

The goal of the Geophysics Program is to increase the safety and welfare of the public by reducing the damaging consequences of earthquakes. The program provides specialized earth science expertise that is essential for evaluation of the seismic safety of critical and hazardous facilities and as input for the development of emergency-response plans and the design of earthquake resistant structures. Specific areas of program activity are (1) earthquake hazard and risk assessment and (2) strong-motion instrumentation data collection.

1. Earthquake hazard and risk assessment

To help minimize the costly toll of earthquakes in California, the Earthquake Hazard and Risk Assessment Program evaluates the earthquake threat for different regions of the state and characterizes the damage to critical lifelines likely to result from an occurrence of the worst-case earthquakes for active faults in each region. These projections are based upon an understanding of the region's geology, analysis of the historic and geologic record of the region's earthquakes, and engineering assessments of the vulnerabilities of lifeline structures to strong shaking and other earthquake phenomena. The published information is used, perhaps most importantly, by local governments in making land-use decisions, in developing effective regional and local emergency-response plans, and in providing the public with earthquake-hazard education. Program staff also provide technical advice on the safety of critical and hazardous facilities and, during periods of heightened volcanic or seismic hazard, coordinate and participate in hazard assessment activities and emergency-response planning with federal and local government agencies as well as other State agencies.

a. Damage scenarios

The devastating impact of an earthquake on existing urban centers can be reduced by effective emergency-response planning. Post-disaster operations such as search and rescue and restoration of lifelines require an understanding of the anticipated geographic distribution of damage and casualties, as well as performance of specific lifelines.

An earthquake damage scenario characterizes the probable impacts of a credible, worst-case earthquake originating from a particular geologic fault. When a fault is known to have produced a major historical earthquake--as is the case with the northern San Andreas fault which produced the 1906 San Francisco earthquake--the historical earthquake is used as the scenario event. Once the scenario earthquake is defined (epicenter, magnitude, amount and nature of fault movement), the next step is to map the areal distribution of damaging levels of ground shaking and of other damaging earthquake phenomena. Based on this map and an understanding of the special vulnerabilities of the region's major lifelines, maps are prepared that show the performance of major highways and airports, railroads and marine facilities, communications networks, water supply and waste disposal facilities, electrical power facilities, natural gas and petroleum facilities, and schools and hospitals. The maps show the post-earthquake

operational status of these lifelines upon which recovery operations will depend. The damage scenarios thus provide information that will enable communities in the region at risk to make realistic preparations and to plan effective emergency-response and post-disaster strategies. The damage scenarios are also useful in land-use planning and for targeting areas for the implementation of hazardous-building abatement programs.

Two damage scenarios have been published and are available. One is the "Earthquake Planning Scenario for a M 8.3 Earthquake on the San Andreas Fault in the San Francisco Bay Area" (DMG Special Publication 61). The other is the "Earthquake Planning Scenario for a M 8.3 Earthquake on the San Andreas Fault in Southern California" (DMG Special Publication 60).

During 1985-86, Program staff completed a damage scenario of major lifelines in the San Francisco Bay region for a magnitude 7.5 earthquake on the Hayward fault. This earthquake damage scenario is scheduled for release in fall of 1986.

Two more scenarios are under preparation, one for the Los Angeles region for a M 7.0 earthquake on the Newport-Inglewood fault, and one for the greater San Diego-Tijuana metropolitan area for a M 6.8 earthquake on the Silver Strand fault. These scenarios are planned for completion during fiscal year 1986-87.

b. Seismic hazard studies

Loss of life and property due to earthquakes affecting future urban developments can be reduced by effective land-use planning; that is, by reducing exposure to seismic hazards through appropriate siting and design of structures. Although land-use decision practices have incorporated fault rupture hazards since 1972, ground shaking hazard is considered primarily for critical facilities. For example, State highway structures are designed to withstand the maximum level of earthquake shaking expected for a region.

During 1985-86, Program staff completed a draft and revision of DMG Map sheet 23, "Maximum Credible Rock Acceleration in California," which is used by the California Department of Transportation in the design of transportation facilities statewide. This map portrays the geographic distribution of ground shaking, considering the largest earthquakes expected from all potential earthquake sources throughout the state. Since the first publication of this map in 1974, new information has been obtained on the location and earthquake-generating potential of faults, as well as on the development of strong ground shaking as earthquake generated waves pass through the earth to various locations throughout the state. These new insights are the basis for revising this important publication.

A report was completed that evaluates the effects of local geologic site conditions on ground motion near Coalinga. This study is part of a continuing effort to develop a methodology for mapping shaking hazard from future large earthquakes near urbanized areas. A similar study was begun near Chalome Valley to test methods of estimating shaking expected from the next Parkfield earthquake, which is predicted to occur by 1992.

c. Seismic monitoring

Portable seismographic recorders are used in studies of aftershocks following damaging earthquakes and in the monitoring of seismicity during periods of heightened concern about a possible imminent earthquake or volcanic eruption. Earthquake aftershocks are monitored as a means of gaining a better understanding of the fault that produced the earthquake and in order to determine the relation between local ground conditions and the distribution of earthquake shaking and damage during the earthquake.

Five permanent seismographic recorders are maintained for public display in the Sacramento area, one in the State Capitol, and four in the Division's regional office. The recorders have been popular exhibits since their installation, and enable the Division staff, the public, and legislative personnel to be aware of California earthquakes as they happen. A computer-controlled electronic message board installed adjacent to the seismograph recorder in the State Capitol provides information to the staff and visitors of the Capitol about significant earthquakes affecting California.

Timely seismological data is also supplied to the Division by the Seismological Laboratory at Cal Tech and the Seismographic Stations of U.C. Berkeley. These networks provide timely information on all earthquakes of Richter magnitude 4 or greater. Further information on seismicity in California is provided by the U.S. Geological Survey through a data-exchange agreement.

d. Volcanic hazards monitoring

Continued concern by scientists and the public for the possibility of volcanic activity in the Mammoth Lakes region has brought legislated responsibility to DMG for monitoring and assessing volcanic hazard potential to ensure public safety. During 1985-86, the Division continued normal operation of an automated seismic data analysis system that monitors seismic data signals that come from the Long Valley caldera over the State microwave network. DMG's automated seismic data analysis system detects, locates, and analyzes earthquake signals in near-real time, and notifies key staff scientists by telephone 24 hours a day when unusual seismic activity or a system malfunction occurs. Several improvements were made to the analysis system, resulting in more precise earthquake location and magnitude estimates and a 30% reduction in the time required to process an event.

Over 2,500 earthquakes were recorded and processed in 1985-86. The system enables the Division to provide timely warning or advice on the imminence of a volcanic eruption to the State Office of Emergency Services and Federal, local, and other State agencies.

e. Southern California Seismic Project

During 1985-86, a forecast seismic intensity map was prepared for a predicted earthquake affecting the San Diego-Tijuana metropolitan area. A lifetime-planning scenario from this was undertaken and will be completed in early fiscal year 1986-87. The information captured in the scenario will be

used not only by local planners, but also by a bi-national, U.S.-Mexico earthquake preparedness program for the San Diego-Tijuana area.

f. Advisory Services

Reviews relating to seismology are required to assess the adequacy of seismological data in documents for planning and design considerations of various public projects. These reviews are done by geologists and geophysicists using the most current information and state-of-the-art techniques. In 1985-86 Program staff reviewed the seismic safety aspects of environmental impact reports and hospital safety reports required by the Hospital Safety Act (SB 519). Other important reviews included seismic safety issues associated with the Diablo Canyon nuclear power plant and a proposed State prison near Avenal in Fresno County.

2. Strong Motion Instrumentation Program

The Strong Motion Instrumentation Program (SMIP) was created to provide information on the force of ground motion and the deformation induced in structures by earthquake-generated ground motion in California. This information is critical to the efforts of engineers trying to design earthquake-resistant structures. SMIP was established after the San Fernando earthquake in 1971, when Chapter 8 of Division 2 of the Public Resources Code (SB 1374) was signed into law. The Department of Conservation's Division of Mines and Geology was designated as the responsible managing agency.

SMIP is installing, maintaining, and monitoring a network of strong-motion instruments to study the nature of strong earthquake motion and to collect, process, and disseminate data for application to the design of earthquake-resistant structures. This activity is supported by a special fund derived from a fee applied to construction permits issued by cities and counties. The objective of the strong-motion program is to obtain statewide detailed records of the response of rock and soil units and of engineered structures to strong shaking caused by earthquakes. The accelerograph, an instrument that measures the forces generated by seismic waves, is used to record these data.

The sites instrumented by SMIP are selected with the advice and assistance of the Strong Motion Instrumentation Committee of the Seismic Safety Commission. The Committee encourages a variety of individuals, organizations, and agencies to cooperate in nominating sites and structures for instrumentation. Ultimately, the State strong-motion instrument network will include about 400 buildings, 30 dams, 40 transportation structures, 25 lifeline facilities, 400 isolated ground response sites, and 20 special arrays.

During the 1985-86 the Strong Motion Instrumentation Program completed its fourteenth year of operation. SMIP activities are conducted out of offices in Sacramento and San Bernardino. During the fourteen years of operation, a total of 316 ground response stations have been installed. In addition, 80 buildings, 24 dams, seven transportation structures, and one power generating plant have been instrumented. In total, the 428 stations contain nearly 2,630 seismic data sensors. As shown on the map in Figure 5, the facilities instrumented are located throughout the state, in small cities as well as large urban areas.

Strong-motion instrument installation activity during 1985-86 included the installation of five ground response stations and the instrumentation of nine buildings. The 15 stations installed during 1985-86 are listed in Table 1; they required the installation of 145 sensors and represent a corresponding increase in the maintenance effort.

The installation of strong-motion recorders in structures and at ground-response stations has begun to provide important and instructive data on the principal characteristics of strong earthquake shaking. As one example, Figure 6 shows the strong-motion data recorded at a county administration building in Rancho Cucamonga during the Redlands earthquake of October 2, 1985. This building is a new construction type which incorporates elastomeric isolators at the base of the building. The building is constructed in this manner to reduce the seismic motion of the building by isolating it from the motion of the ground. The figure shows that during this earthquake the high-frequency part of the ground shaking was not transmitted past the isolators into the building superstructure. Data such as these are invaluable for guiding seismic retrofit efforts and improving seismic design codes and construction practice.

Table 1. Facilities instrumented by SMIP during 1985-86.

Station	County	Description	Sensors
Berkeley Alta Bates Hospital	Alameda	2-story eccentric-braced steel frame	12
Bridgeport	Mono	Ground-response station	3
Coyote Lake Dam Downstream	Santa Clara	Ground-response station	3
Eureka Silvercrest Apartment grounds	Humboldt	Ground-response station	3
Hayward BART Station Grounds	Alameda	Ground-response station	3
Hayward BART Elevated Grounds	Alameda	Concrete elevated track station	16
Milpitas Marshall Electronics Building	Santa Clara	2-story concrete tilt-up shear wall building	13
Rancho Cucamonga San Bernardino County Law & Justice Building	San Bernardino	4-story base-isolated braced steel frame building	19
Redlands Interstate Van Lines Warehouse	San Bernardino	1-story precast concrete tilt-up warehouse	12
Richmond City Hall	Contra Costa	3-story concrete frame and shear wall building	13
Richmond City Hall Grounds	Contra Costa	Ground-response station	3
Richmond Hilltop Medical Center	Contra Costa	3-story steel frame building	12
Sacramento State Capitol Building	Sacramento	5-story concrete shear wall building plus dome	12
San Bruno Bayhill Office Building	San Mateo	6-story concrete frame building	13

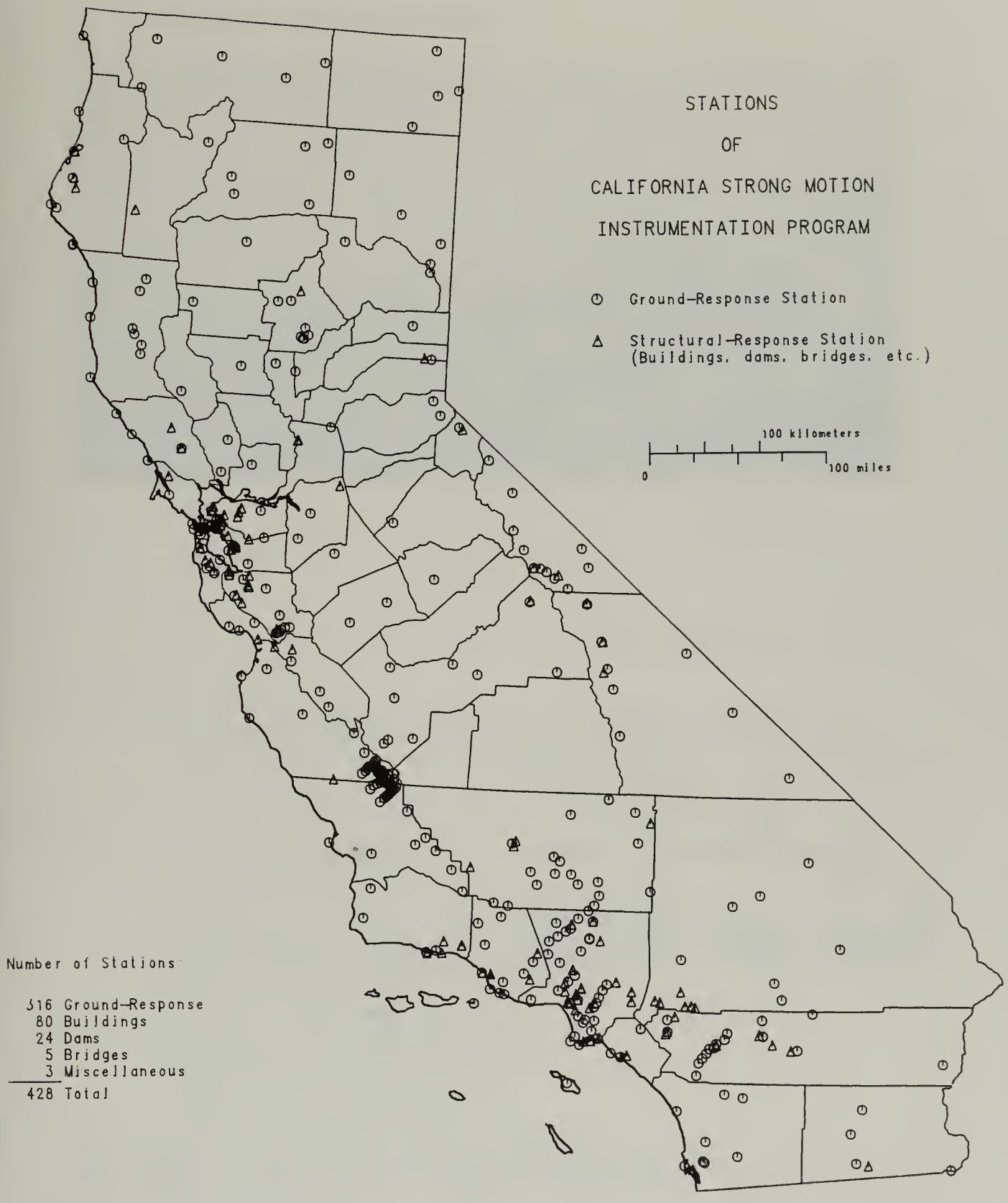
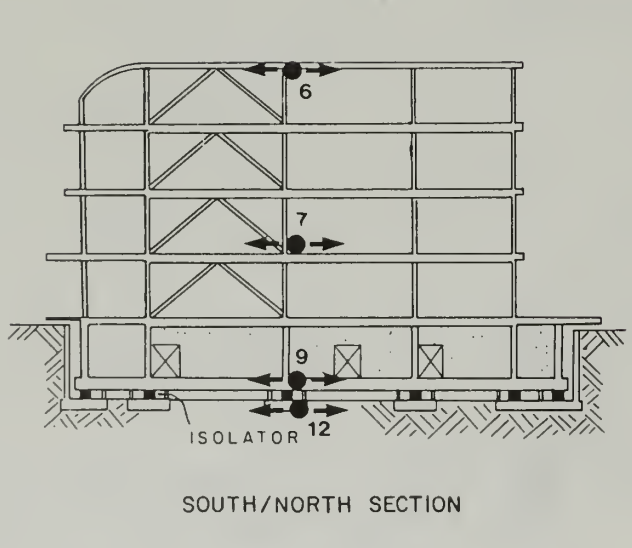


Figure 5. Earthquake strong-motion monitoring stations of the California Strong Motion Instrumentation Program. At the end of fiscal year 1985-86, 428 stations had been installed statewide.



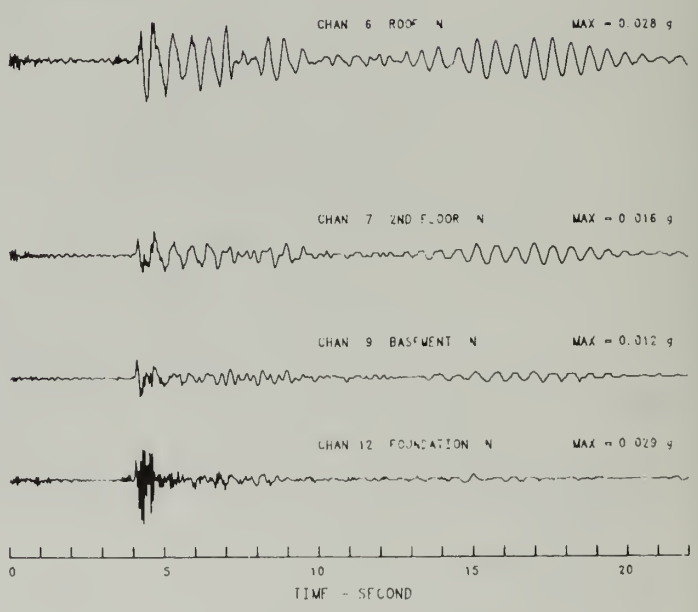


Figure 6. Strong-motion records obtained during the 2 October 1985 Redlands earthquake in the San Bernardino County Law and Justice Center in Rancho Cucamonga, a base-isolated building. The records show that the high-frequency motion of the foundation was not transmitted through the isolators to the basement and the rest of the building during this earthquake.

IV. Mined Resource Assessment Program

The Mined Resource Assessment Program conducts a number of activities to develop useful information on the mineral resources of California. These activities include geological studies, geochemical studies and applied geophysical studies.

1. Geological studies

The geology section of the Mined Resource Assessment Program conducted studies dealing with the following topics: mineral commodity reports, current mining activity, review of proposed public land withdrawals from mineral entry, and special geological priority projects.

a. Mineral commodity reports

The following mineral commodity reports were completed in 1985-86.

Gold
Silica
Pumice, Pumicite, Perlite and Volcanic Cinders
Zeolites in California
Gold Fact Sheet

b. Current mining activities

The following articles dealing with current mining activities were prepared in 1985-86.

1984 Mining Review
The McLaughlin Mine, Napa, Yolo and Lake Counties
Update of Mineral Property Report files

c. Review of possible public land withdrawals from mineral entry.

The following reviews of possible public land withdraws from mineral entry were prepared in 1985-86

Panamint Dunes Wilderness Study Area
Hunter Mountains Wilderness Study Area
North Algondones Dunes Wilderness Study Area
Little Sand Springs Wilderness Study Area
Whitewater Wilderness Study Area
Kelso Dunes Wilderness Study Area
Wildrose Canyon Wilderness Study Area
Slate Range Wilderness Study Area
Saline Valley Wilderness Study Area
Owlshead Mountains Wilderness Study Area
Whipple Mountains Wilderness Study Area
South Providence Mountains Wilderness Study Area

Chemehuevi Mountains Wilderness Study Area
Chuckwalla Wilderness Study Area
Eagle Mountains Wilderness Study Area
Bighorn Mountains Wilderness Study Area
Coxcomb Mountains Wilderness Study Area
U.S. Senate Bill 2061, Cranston
Tahoe National Forest Management Plan
Sequoia National Forest Management Plan
Angeles National Forest Management Plan

d. Special geological priority project

The following special geological studies were conducted during 1985-86.

Selenium article for CALIFORNIA GEOLOGY magazine
California Gold Symposium held in Sacramento, October 1985

2. Geochemical studies

The following geochemical study was completed during 1985-86.

Basic statistical programs for geochemical analyses for use with the IBM PC computer.

3. Geophysical support studies

The Division's geophysics support unit provides geophysical support services for other Division programs including the mineral and seismology programs. In addition, the applied geophysics unit carries out independent projects such as compilation of gravity and magnetic maps.

Most of the geophysical surveys conducted by DMG in 1985-86 were in support of SMARA programs. Other surveys were primarily basic geophysical studies. The geophysical data resulting from these studies are used principally to define fault zones and other geologic structures, to determine local bedrock depths, and to locate certain types of rocks, mineral deposits, and geothermal resources, or areas favorable for such resources. Because DMG's geothermal program was terminated at the end of 1984-85, no new geothermal studies were done; the only activity of this kind was related to the completion and publication of the work done earlier.

a. Gravity mapping

Preparation of various State gravity maps continued. No new gravity maps were printed this year, but both the San Bernardino and the revised Santa Rosa 1° x 2° quadrangles are ready for printing. Work also continued on the San Francisco-San Jose and the Trona-Kingman 1° x 2° sheets. These

maps should be completed during 1986-87. Final corrections are now being made to the Santa Ana sheet compilation by the U.S. Geological Survey, and this map should be available soon.

An Isostatic Residual Gravity Map (scale, 1:750,000), which covers the entire State, has been submitted to DMG by the U.S. Geological Survey for possible publication in the California Data Map Series. This map represents a substantial investment of time and effort by DMG because it utilizes much data originally obtained by DMG. Possible means of financing the publication of this map continue to be discussed with the U.S. Geological Survey.

b. Aeromagnetic mapping

Preparation of the 1:250,000-scale aeromagnetic map series is continuing. The Weed, Santa Rosa, Sacramento, Alturas, Needles, and San Bernardino sheets have been completed. The San Francisco-San Jose, the Trona-Kingman, and the Chico sheets are in preparation.

Contoured NURE aeromagnetic data are available for almost all of California, so this can be used for our purposes where more detailed data are not available.

An aeromagnetic map of the Cascades region in California submitted to DMG by Oregon State University has been prepared for publication in the Geologic Map Sheet series. This map is now planned to be published in 1986-87. It should be particularly useful for studies of geothermal resources and other mineral resources of the region.

c. Geophysical projects to support other investigations

Geophysical field and office support for several mineral and geologic hazard investigations was provided in the form of magnetic, gravity, seismic, and electrical resistivity surveys and data analyses. The geophysical surveys provided information pertinent to the identification of buried faults and other stratigraphic structures, variations in the thickness of subsurface strata, the identification of certain types of rocks in the subsurface, and the magnetic properties, electrical resistivities, and densities of local rock units.

Mineral projects supported include the SMARA mineral land classification of the Camino, Mokelumne Hill, Valley Springs, and San Andreas quadrangles in the Sierra Nevada Foothills, and a number of SMARA quadrangles in the Kingman and Needles sheets in the Mojave Desert. An article was written on the results of a magnetic geophysical study of part of the Ivanpah mining district in the Kingman sheet area, and is scheduled for publication in the August issue of CALIFORNIA GEOLOGY.

An article summarizing DMG's geophysical studies of geothermal resources in the Santa Rosa-Sonoma area was written and published in the November 1985 issue of CALIFORNIA GEOLOGY.

A small geophysical study was done for the Department of Justice to demonstrate the use of magnetic methods for locating possible unmarked graves (Open-File Report 86-11 SAC).

d. Geothermal resource studies

The Division's geothermal resource program was terminated at the end of 1985-86. However, one of the final products of this program, a report on the geothermal systems of the Mono Basin-Long Valley Region for the U.S. Department of Energy, was released as Open-File Report 85-19 SAC. This report covers an area in eastern California and western Nevada, and was done as a cooperative project with the staff of the University of Nevada (Las Vegas). Another report on the geophysical investigations of geothermal resources in the Santa Rosa-Sonoma area was published in the November 1985 issue of CALIFORNIA GEOLOGY.

V. Geologic Investigations Program

The Geologic Investigations Program provides both basic and applied geologic information--primarily, but not solely, in the form of maps. This information is used in mineral resource development, in land-use planning and regulation by local government, in timber harvest planning, in development-site evaluation studies, and in other endeavors requiring sound information on the geology of the state. The specific areas of program activity are (1) fault evaluation and zoning, (2) regional geologic mapping, and (3) timber harvest plan review.

1. Fault evaluation and zoning

The Division's fault evaluation and zoning unit was established by the Alquist-Priolo Special Studies Zones Act (APSSZ) of 1972 (Public Resources Code, Division 2, Chapter 7.5). The objective of the law is to provide for public safety from surface rupture in hazardous fault zones by restricting construction astride active fault breaks.

Under the APSSZ Act, the State Geologist delineates Special Studies Zones about one-quarter mile wide along potentially hazardous faults, including the San Andreas, Calaveras, Hayward, and San Jacinto faults. Under guidelines adopted by the State Mining and Geology Board, local governments permit certain development projects in the Special Studies Zones only after geologic studies show building sites to be free from hazardous faults. Generally, structures for human occupancy are not permitted within 50 feet of an identified trace of an active fault.

The Special Studies Zones (SSZ) maps delineate areas along active fault breaks found to be potentially hazardous because of possible surface rupture. These maps are drawn at a relatively large scale (one inch equals 2,000 feet) to assure that the boundaries of the zones are adequately displayed for land-use regulatory purposes.

The four major faults named in the Act--the San Andreas, the Calaveras, the Hayward, and the San Jacinto faults--were initially zoned on the basis of available existing data. When the zonation of other faults "sufficiently active and well-defined" (PRC, Sec. 2622) was begun, it became apparent that in many cases the available data were not sufficient for the purpose of zonation. In recognition of this insufficiency of data and the large number of potentially active faults in California that needed to be evaluated for possible zonation, an expanded program was initiated in 1976 to map and evaluate the other faults in ten scheduled regions of the state (Figure 7). This expanded program--known as the Fault Evaluation and Zoning Program--includes the detailed mapping of faults using field and aerial photographic methods. At this time, new criteria for zonation were defined based upon the Division's zoning experience. Besides carrying out scheduled evaluations of specific regions of the state, the unit also evaluates previously zoned faults for possible revision or deletion when taking another look is warranted by new data. The Division's Fault Evaluation and Zoning Program is described fully in revised Special Publication 42, "Fault-Rupture Hazard Zones in California," which was published in September 1985.

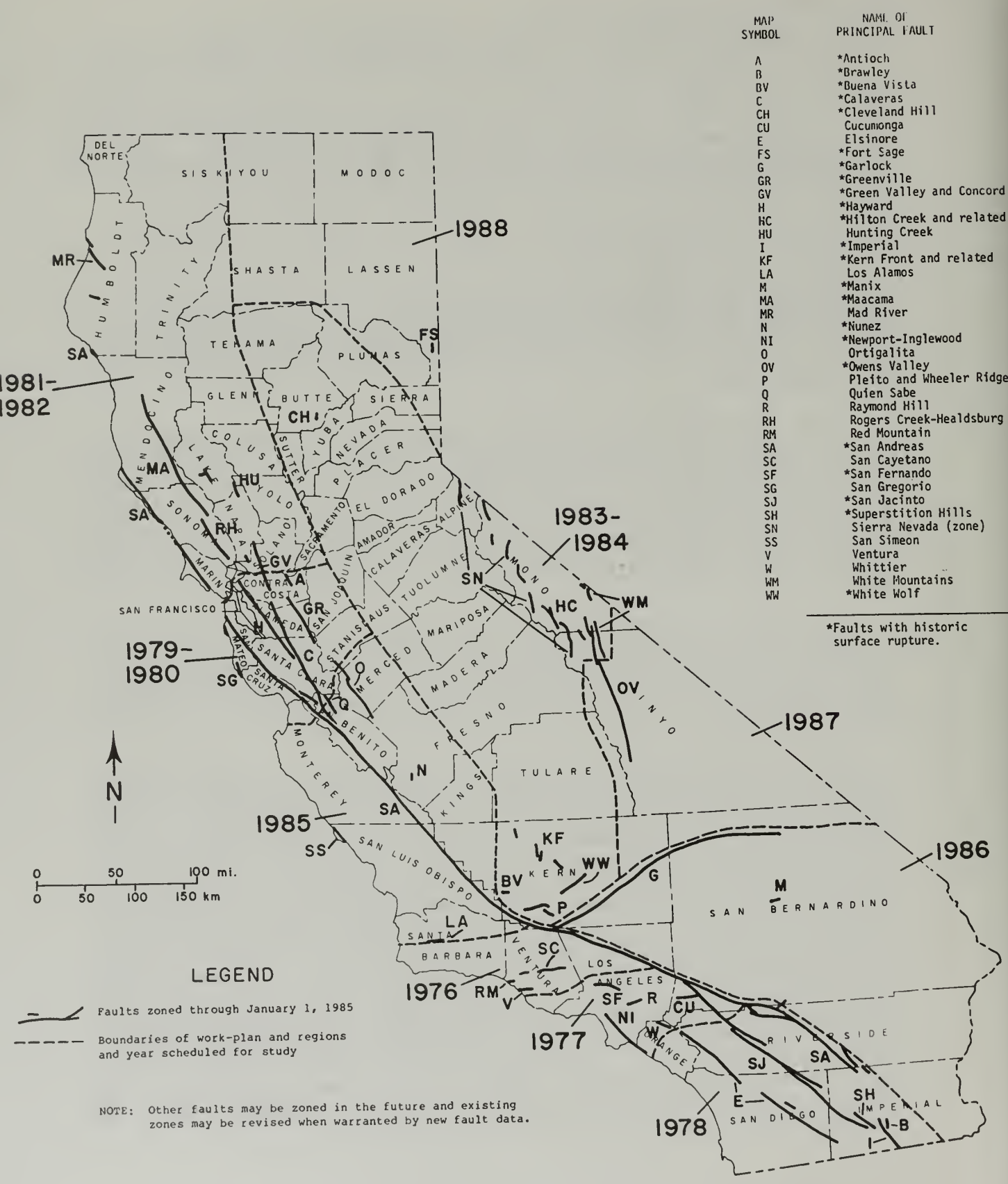


Figure 7. Principal faults in California zoned for special studies under the Alquist-Priolo Special Studies Zones Act of 1972. Dashed lines and dates identify work-plan and priorities for studying areas under the Fault Evaluation and Zoning Program, 1976 to 1988.

Figure 7 shows the breakdown of regions in the state scheduled for evaluation, including the regions where evaluations have been completed. Also shown in Figure 6 are the principal faults in California that have been zoned under the Alquist-Priolo Act.

During 1985-86, fault evaluation studies initiated the previous year were completed in the southern Coast Ranges and in portions of Ventura, Los Angeles, and Orange counties. As a result of this work, 32 new and revised Preliminary Review Maps of Special Studies Zones were issued on January 1, 1986. Following a three-month period of review by local and state agencies, these maps were revised and issued as official maps on July 1, 1986 (Figure 8). These new and revised zones effect 10 cities and 10 counties. New Special Studies Zones established included portions of the San Simeon, Ortigalita, Los Alamos, San Cayetano, and several other faults. Revised Special Studies Zones also were issued for segments of the San Andreas, Calaveras, Paicines, Quien Sabe and Newport-Inglewood faults. Evaluations of these faults, as well as other faults that were not zoned, are summarized in Open-File Report 86-3 SF.

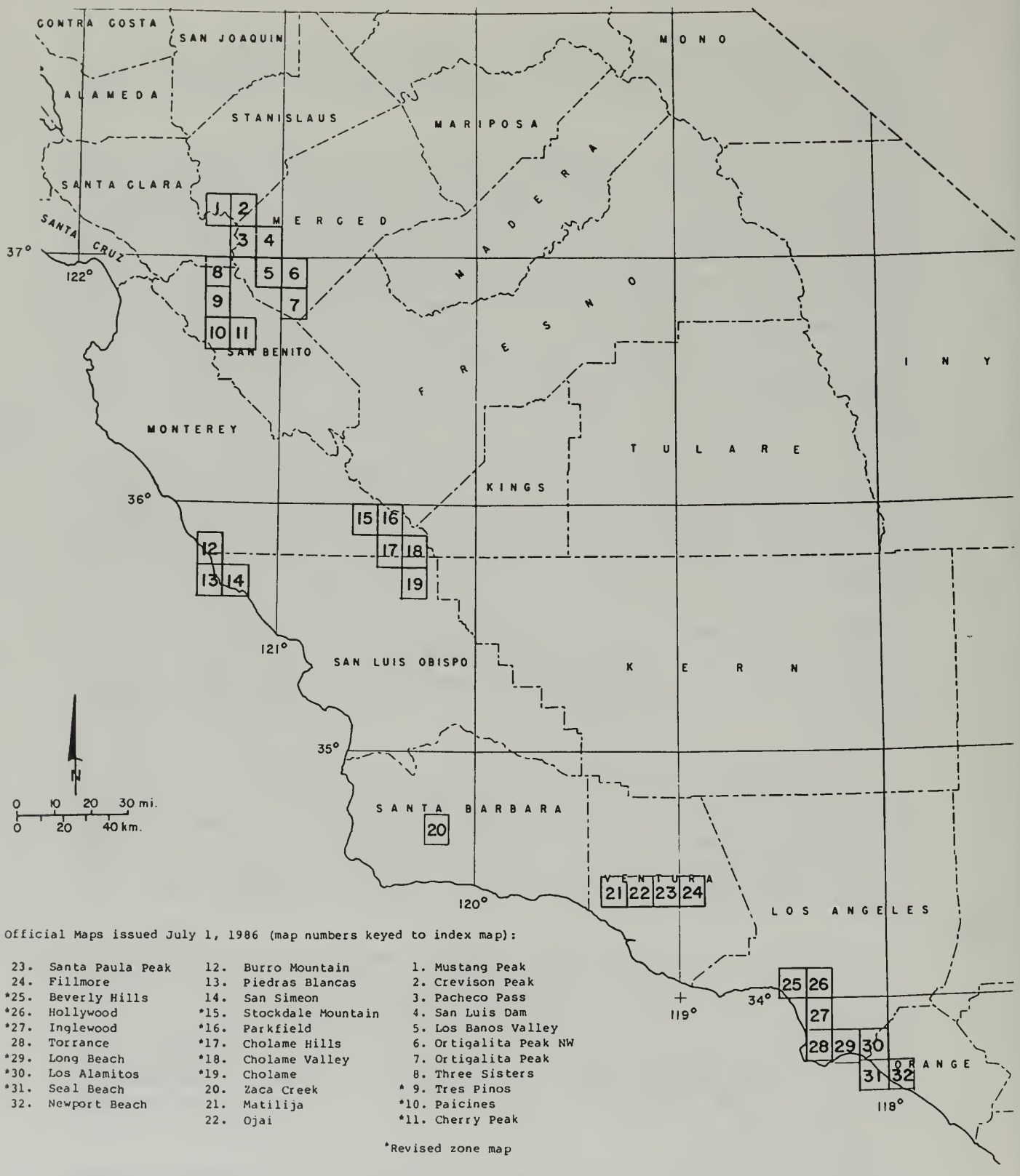
Meanwhile, fault evaluation studies were initiated in the Mojave Desert region and elsewhere. Although this work was only about 50% complete by the end of the fiscal year, it is apparent that the Pinto Mountain, Helendale, Linwood, North Frontal, and several other faults are "sufficiently active and well-defined" to meet current zoning criteria. These evaluations are scheduled for completion on January 1, 1987.

Other studies also were undertaken outside the Mojave Desert in order to evaluate parts of the San Gabriel and the San Jacinto faults. Work on the San Gabriel fault is complete and local zoning is recommended near Saugus. Work on the San Jacinto fault north of San Jacinto was not yet complete at the end of the fiscal year.

For each fault evaluated under the Fault Evaluation and Zoning Program, a Fault Evaluation Report (FER) is prepared to summarize data on fault locations and recency, and to make zoning recommendations. During the fiscal year, ten FERs were completed and several others were underway. A total of 179 FERs have been completed since the inception of the Program in 1976, and are available for public reference at the Pleasant Hill and Los Angeles regional offices of the Division.

In addition to evaluating and zoning faults, other functions of the Division under the APSSZ Act include (1) the filing of geologic reports for development sites within the Special Studies Zones and (2) review of waiver requests in lieu of a geologic report as provided for in PRC, Sec. 2623. By the end of 1985-86, a total of 1,927 geologic reports were on file and available for public reference at the San Francisco Regional Office in Pleasant Hill. Two waiver requests were processed during the fiscal year, bringing the total for waiver requests processed to 72.

Another important activity of the program staff is to provide information about APSSZ Act, the Division's fault evaluation and zoning program, and fault-rupture hazards to both the public and private sectors. It is estimated that the program staff spent 15 to 20 percent of their time responding to hundreds of



Official Maps issued July 1, 1986 (map numbers keyed to index map):

23. Santa Paula Peak
24. Fillmore
*25. Beverly Hills
*26. Hollywood
*27. Inglewood
28. Torrance
*29. Long Beach
*30. Los Alamitos
*31. Seal Beach
32. Newport Beach

12. Burro Mountain
13. Piedras Blancas
14. San Simeon
*15. Stockdale Mountain
*16. Parkfield
*17. Cholame Hills
*18. Cholame Valley
*19. Cholame
20. Zaca Creek
21. Matilija
22. Ojai

1. Mustang Peak
2. Crevison Peak
3. Pacheco Pass
4. San Luis Dam
5. Los Banos Valley
6. Ortigalita Peak NW
7. Ortigalita Peak
8. Three Sisters
* 9. Tres Pinos
*10. Paicines
*11. Cherry Peak

*Revised zone map

Cities and counties affected by new or revised Special Studies Zones shown on Official Maps of July 1, 1986:

Cities		Counties	
Carson	Inglewood	Fresno	San Benito
Compton	Los Angeles	Los Angeles	San Luis Obispo
Culver City	Long Beach	Merced	Santa Barbara
Gardena	Seal Beach	Monterey	Stanislaus
Huntington Beach	Signal Hill	Orange	Ventura

Figure 8. New and revised Special Studies Zones maps issued July 1, 1986.

inquiries by geologists, planners, building officials, realtors, developers, financial institutions, and others. Staff also provided input or review and advisory services to DMG and other state projects regarding the new acceleration map of California, the Hayward and Newport-Inglewood fault scenarios, the Bay Area Regional Earthquake Preparedness Project, Diablo Canyon Nuclear Power Plant (NRC review), Superconducting Super-Collider Project (U.C. Davis), and other projects.

Finally, Program staff also responds promptly following each moderate to large earthquake in California in order to map fault-rupture that may occur. The purposes of this response is to accurately map surface faulting before the evidence is destroyed and to determine the adequacy of existing zone maps. Field responses during the fiscal year were made following the Hollister M 5.5 and Mount Lewis M 5.8 earthquakes, but no fault-ruptures were detected.

2. Regional geologic mapping

The Regional Geologic Mapping Program (RGM) provides vital, current geologic, geophysical, and seismological data to other Division programs, the public, governmental agencies, private enterprise, and research institutions such as the State's colleges and universities. The specialized information prepared by the Program is used by government agencies as well as private concerns in the mitigation of geologic hazards and the management and development of mineral resources. Although its contribution is indirect, the role the Program plays is an important one.

RGM staff members produce quadrangle maps that portray basic geologic data sets at scales of 1,750,000 (one inch = approx. 12 miles), 1,250,000 (one inch = approx. 4 miles) and 1:100,000 (one inch = approx. 16 miles). The maps are continuously upgraded with new information as it becomes available in order to provide the users with current framework geology of the State of California. These maps and data sets provide baseline information for mineral resources exploration, evaluation and classification, fault evaluation and zoning, seismological investigations and instrumentation, geological hazards assessments, and geologic investigations needed for major development and construction projects.

The RGM is currently working on the compilation of a comprehensive, 1:250,000-scale geologic atlas (Figure 9) of the State. Mapping of each quadrangle includes framework geology, isotopic age data, character/recency of faulting overlays, and bibliographic information. Concurrently RGM is compiling more detailed geologic work along with additional geophysical (gravity and magnetic anomaly) and seismological (epicenter and selected first motion) data at a scale of 1:100,000. These more detailed maps will be available initially through open-file release and ultimately as part of a statewide comprehensive and expandable geologic folio series.

Demand for the RGM products remained high this year. Public information and requests for yet unpublished work continued on a dramatic upswing. The RGM staff continued its upgrading of the indicies to geological mapping and to graduate theses work in geology of California. These indicies are now available upon request but are being prepared for publication by RGM graduate student assistants.

The status of RGM work is illustrated in Figure 9. The San Bernardino quadrangle was completed this year and is currently being printed. Compilation of the Weed, the San Francisco/San Jose, and the Trona/Kingman quadrangles has been completed; these quadrangles are in preparation for publication (in press). Compilation of the Chico quadrangle is nearly complete; it is being prepared for outside review. The Santa Ana/San Diego, the Monterey, and the Susanville quadrangles were started in June; they will be the center of RGM work during 1986-86.

The 1:100,000 scale maps now underway include the Santa Ana, Oceanside, and San Diego quadrangles. These sheets and their individual overlays will be completed for open-file release on about the same schedule as the 1:250,000 atlas sheets of the same areas.

Bulletin 201, which contains an index to mapping used in DMG's Fault and Geologic Maps of California (scale 1:750,000), is scheduled for publication during 1986-87). The bulletin has three parts. Part one focuses on the Fault Map of California. Among several topics, it discusses the evolution of California fault maps, the fault classification used, various fault structures found in the state, fault patterns, major structural blocks and sub-blocks, and fault geometry. Part 2 discusses the Geologic Map of California, including the history of geologic maps of California and a description of the objectives and uses of this map. Part 3 consists of four sections: 1) an index to fault names, 2) a tabulated list of thermal springs and thermal wells, 3) an index to geologic formations; and 4) a detailed map index to the source data used in preparation of the 1:750,000 scale Fault and Geologic Maps of California.

3. Timber harvest plan review

At the conclusion of 1984-85, the Watersheds Mapping Program was completed for the Department of Forestry. During 1985-86, the Division continued the Timber Harvest Plan Review Program for the Department of Forestry. The Timber Harvest Plan (THP) Review Program provides site-specific geologic review of proposed harvesting areas and recommendations for mitigative measures for potential landslide and/or erosion problems. Under the Forest Practice Act of 1973, THPs are submitted to CDF in lieu of EIRs and are reviewed by numerous State agencies to insure that their functional equivalency is retained.

Under the THP Review Program, Division staff geologists perform the following tasks: (1) screen incoming THPs for geologic review; (2) provide geologic input for the review of THPs; (3) reinspect THPs to evaluate mitigative measures recommended during preharvest inspections; (4) provide assistance in the preparation of training classes for professional foresters who are providing CDF inspections; and (5) provide advice to CDF and the Board of Forestry on issues involving geology, such as changes in Forest Practice Rules, chaparral management, and silviculture methods. During fiscal year 1985-86, there were four DMG geologist positions assigned to the THP Program. The Senior Engineering Geologist position and one Associate Engineering Geologist position are located in Santa Rosa; the other Associate Engineering Geologist positions are located in Ukiah and Fortuna. Approximately 225 geologic reviews of THPs were completed. A summary of the 10-year program is presented in the June 1986 issue of CALIFORNIA GEOLOGY.

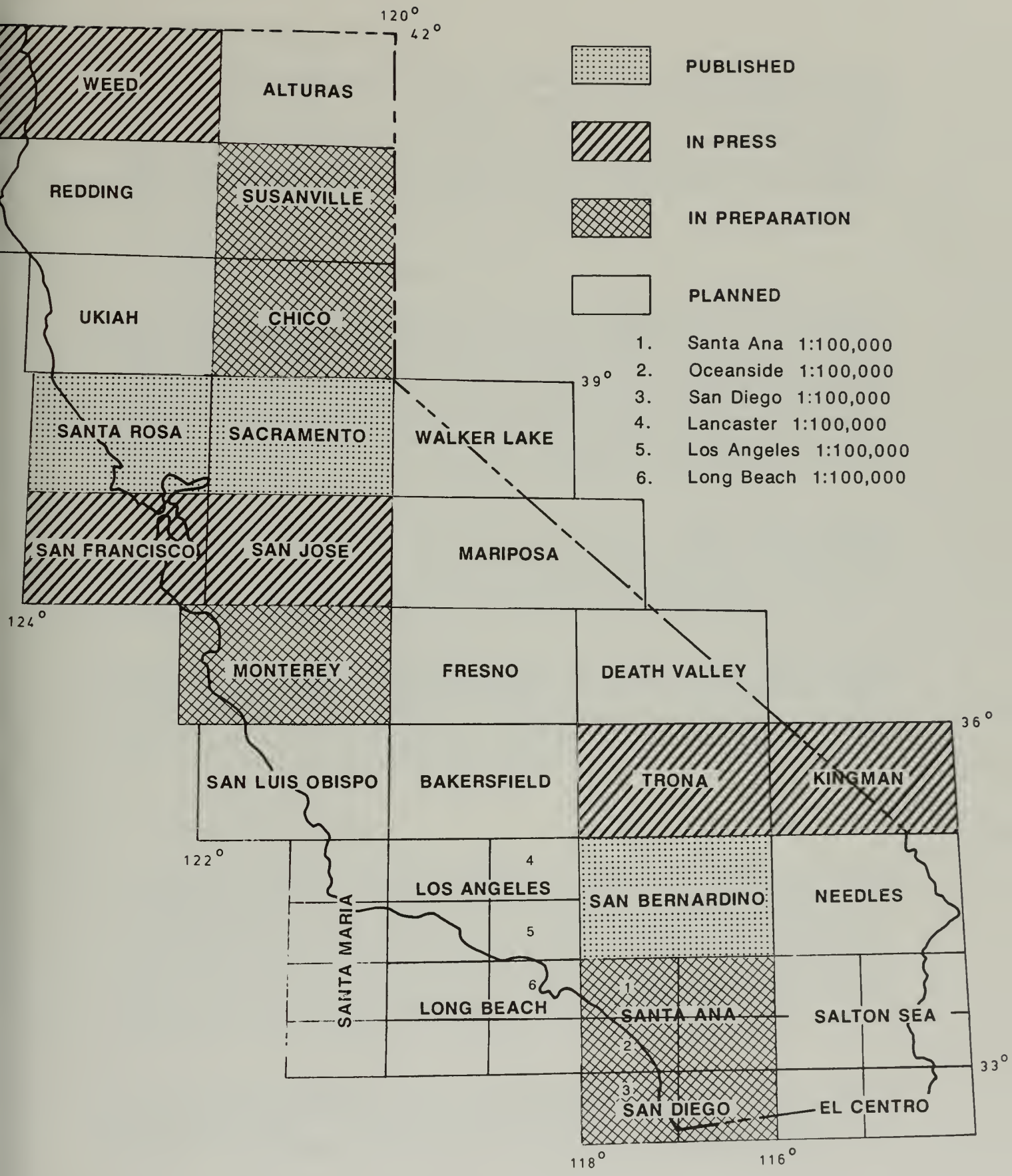


Figure 9. Status of the Regional Geologic Mapping Program.

VI. Geologic Information Program

The Geologic Information Program makes information prepared by Division program activities and other pertinent geologic information available to the general public, including local government, the scientific community, and the public at large. The program also provides technical review of siting reports for certain proposed developments within the state. Specific areas of program activity are (1) information and publications sales, (2) publications production, (3) earth science library, and (4) siting report review.

1. Information service and publications sales

An information service and sales desk is maintained at each of the Division's three regional offices (one at 380 Civic Drive in Pleasant Hill; one at 1516 Ninth Street in Sacramento; and one at 107 South Broadway in Los Angeles). Thousands of inquiries are received at each of these offices annually. Many questions can be answered by supplying copies of DMG Notes or particular issues of CALIFORNIA GEOLOGY. Members of the scientific staff are available to respond to specific technical questions that require the application of specialized professional judgment to answer. For some inquiries, an individual letter from a member of the Division's technical staff is warranted.

Division publications are sold over the counter at these three regional offices, and are available for mail-order purchase from: DMG, P.O. Box 2980, Sacramento, CA 95812. Order prices for individual publications are given in the Division's current "List of Available Publications." Revenue from the sale of Division publications during fiscal year 1985-86 amounted to $200,000.

When a new Division publication is first released to the public, copies are supplied to all "complete depository" libraries in the state, including the State Library, all University of California campus libraries, certain State University campus libraries, and the municipal library systems of Los Angeles, San Diego, San Francisco, and Oakland. Complete depository libraries therefore should have all in-print and out-of-print DMG publications.

2. Publications production

Information about the geology, mineral resources, and geologic hazards of California is published by the Division and distributed to professionals and interested lay-persons. The results of studies made by scientific staff members of the Division and others in the earth science professions are published in CALIFORNIA GEOLOGY, the Division's monthly magazine, and in bulletins, special reports, special publications, preliminary reports, map sheets, geologic maps, open-file reports, and special information pamphlets called DMG Notes. News releases concerning the Division's publications and activities are prepared and distributed to the media.

In producing these publications, the publications staff reviews the technical content of manuscripts, edits manuscripts and maps, drafts illustrations and maps, does graphic design and layout of all publications, coordinates printing and lithography, negotiates printing contracts, and manages the printing budget.

See Appendix I on page 43 for lists of the various publications released during 1985-86.

3. Geology library

The Division's library, located in the San Francisco Bay regional office in Pleasant Hill, is a research and source facility for the Division's professional staff. The books, periodicals, maps, and government documents in the collection represent an up-to-date, comprehensive selection of materials of use to Division scientists and investigators.

4. Critical-siting report review

The Division provides reviews of geological, seismological, and mineral resource aspects of technical reports produced by other state, federal, and local government agencies. The purpose of the DMG reviews is to provide assurance to those agencies that the treatment of the geological, seismological, and mineral resources aspects of those reports has been thorough and accurate, and has applied state-of-the art technical methodology with respect to any geological hazard or mineral resource issues that may be present. Technical information and interpretive judgments are brought to bear in the review process. During 1985-86, siting report review activities included California Coastal Commission site reviews, review of hospital sites, and analysis of Environmental Impact Reports (EIR). Reimbursements for work done by the siting report review unit were provided by the Office of the State Architect and the California Coastal Commission.

Project documents that come under review are treated as either "routine" or "major" documents. Major documents are those that require multiple reviews by different specialists within the Division. Of the 6,000-plus documents reviewed during 1985-86, 40 involved major document review.

a. Environmental impact report reviews

The Division continued to review Environmental Impact Reports (EIRs) for a variety of projects, outer continental shelf projects including subdivisions, school sites, mining activity, dam sites, and hazardous waste disposal sites. The problems considered in the review are earthquake shaking, fault rupture, landsliding, erosion, expansive soil, tsunami, subsidence, volcanic eruption, mineral resource conservation, and mined-land reclamation. The Division's EIR guidelines are presented in DMG Note 46. During 1985-86, 420 EIRs were reviewed.

b. Hospital site report reviews

The Division continued to review reports under the provisions of the Hospital Safety Act (Health and Safety Code), which became effective March 7, 1973. This Act requires that new hospitals, including additions, reconstructions, and out-patient facilities, be functional during and after an

earthquake or other natural disaster. During 1985-86, the Division reviewed 96 new and supplemental geologic/seismic hospital-site reports that were submitted by consulting engineering geology firms to the Office of the State Architect.

Along with the review activity, Division staff continued to attend regular meetings of the State Building Safety Board and the geotechnical subcommittees to develop new administrative regulations.

APPENDIX I: Publications released during 1985-86.

Seventy-Seventh Report of the State Geologist (1984-1985). No charge. This annual report explains the goals of the Division, describes its organization and programs, reports activities of the fiscal year, and lists Division personnel.

Special Publication 81. Mineral Commodity Report - Sodium Sulfate. By Hasmukhrai H. Majmundar. 1985. 11 p. $1.00. This report on the availability and demand for sodium sulfate (salt cake) in the United States, the world, and California, is one of a series of Mineral Commodity Reports prepared by the Department of Conservation, Division of Mines and Geology (DMG) to describe the mineral commodities of significant importance to California and the nation.

Special Publication 82. Mineral Commodity Report - Salt. By Hasmukhrai H. Majmundar. 1985. 16 p. $1.00. This report describes the importance of salt (NaCl) to California and the nation, its availability, and current demand. In 1983, the U.S. produced 33 million tons of salt, sold or used 31.5 million tons, and imported 5.5 million tons. The demand for salt in the U.S. is expected to increase at an annual rate of 1.5 percent through 1990.

Special Publication 83. Mineral Commodity Report - Sodium Carbonate. By Hasmukhrai H. Majmundar. 1985. 16 p. $1.00. In 1983, the U.S. produced 8.4 million short tons of sodium carbonate, imported 0.02 million short tons, and exported 1.6 million short tons. The demand for sodium carbonate (also called "soda ash") in the U.S. is expected to increase at an annual rate of about 1.2 percent through 1990.

Special Publication 84. Mineral Commodity Report - Phosphate Rock. By John L. Burnett. 1985. 16 p. $1.00. Phosphate rock is used principally as a fertilizer in California. Although commercial production of phosphate rock has been very limited in California, low-grade phosphate is common. The Miocene marine sedimentary rocks in the Coast Ranges contain the most promising reserves. These materials have not been developed because much higher grade materials are mined in Florida, North Carolina, and Idaho, and imported into California. The limited commercial production in California has been confined to the New Cuyama deposit in Santa Barbara County.

Special Publication 85. Productive Second Uses of Mined Land Conference. Jointly sponsored by: California Department of Conservation, Division of Mines and Geology and The Institute for the Human Environment. 1984. 174 p. $9.00. The conference sought to promote advances in the practice of mined land reclamation planning by focusing on the opportunities for second uses of mined lands. Experts from the fields of mined land reclamation and land use planning, mining, economics, marketing, government, and conservation participated in the exchange. The report summarizes the three-day event.

Special Publication 86. Foothill Counties Mining Handbook. By the Sierra Economic Development District and the Sierra Planning Organization Mining Task Force. 1986. 106 p. $4.00. This is a reference and educational source book for local governments, communities, and the general public. It is primarily designed to provide assistance in resolving controversial mining issues in four Sierra Nevada foothill counties: Nevada, Placer, El Dorado, and Sierra counties.

Special Publication 87. Placer Gold Recovery Methods. By Michael Silva. 1986. 32 p. $2.50. This publication is designed for those interested in the various aspects of placer gold recovery. There are many different types of efficient placer gold recovery systems available today. Factors considered in the design of a placer gold recovery operation at a particular site must include: initial and operating costs versus recovery, ore grade and volume, gold size distribution, and processing capacity. Special Publication 87 is illustrated with figures, tables, photos, and detailed explanations that describe the placer gold recovery equipment and methods that are commonly used. Particular emphasis is placed on descriptions of modern gold recovery technologies such as rotating spirals, shaking and rotating tables, tilting frames, bowl concentrators, dry washers, and jigs.

Special Report 156. Mineral Resource Potential of the Rockhouse Basin Wilderness Study Area, Kern and Tulare counties, California. By G. Taylor, R. Lloyd, J. Alfors, J. Burnett, M. Stinson, R. Chapman, M. Silva, C. Bacon, and T. Anderson. 1983. This report presents the results of a geologic, energy, and mineral survey of the Rockhouse Basin Wilderness Study Area in the southern Sierra Nevada Mountains. The work was contracted as part of a BLM study to determine the suitability of the Rockhouse Basin Area for Recommendation for inclusion into the National Wilderness Preservation System.

Bouguer Gravity Map, Sacramento Sheet. Compiled by H.W. Oliver, S.L. Robbins, and C.W. Roberts. 1985. Scale 1:250,000. Folded in envelope, $4.00. Bouguer gravity values were contoured with a 5-milligal contour interval and over-printed on the Sacramento regional geologic map, with geologic units shown in color. One diagrammatic cross section from the Vaca fault on the western edge of the map area, through the Bear Mountain and Melones fault zones, to the southern tip of Lake Tahoe is included on the map sheet.

The Soil Conservation Advisory Committee: First Year Report. 1985. This report describes the Soil Conservation Advisory Committee's assessment of the condition of the State's soil resource and the Committee's accomplishments to date.

Recommendations for a California Soil Conservation Plan. 1986. This working paper represents the efforts of the Soil Conservation Advisory Committee to prepare a draft California Soil Conservation Plan.

b. California Geology

The following articles were published during the year in DMG's monthly earth science magazine CALIFORNIA GEOLOGY:

Sharktooth Hill
Project Update Geology
Geologic Hazards, Negligence, and Real Estate
Mineral Industry of California, 1984
Significant Earthquakes, 1984
Historic Map of Yosemite
Borate Mining History in Death Valley
Gold in the California Desert
Dry Placer Mining
Sierra Nevada Eastern Escarpment
Earthquake Hazards Workshop
A Geologic Guide to Titus Canyon - Death Valley National Monument
Assessment of 1982-83 Winter Storms Damage Malibu Coastline
California Ground Water Resources
Tunell Economic Geology Collection
Gold Bearing Conglomerate, Hornbrook Formation
1984 Mining Review
Paymaster Mine Stampmill
Aggregate Pit Reclamation, San Fernando Valley
Registration Board News
State Mining and Geology Board News
Geophysical Investigations and Geothermal Resources, Santa Rosa-Sonoma Area
Gold in the Transverse Ranges
Living with the California Coast
Statement of Ownership
Project Rise-LA
Mineral Assessments
Rainfall Conditions for Abundant Debris Avalanches
USGS Grants
A Forty-Niner's Account
Rock Engineering Conference
Cascade Volcanoes, Debris Flow Potential
Benitoite-Official State Gem
New Interpretation of Geologic Relationships Between the San Gabriel and San Andreas Faults
AGS Conference
A New Type of Lode Gold Deposit, the McLaughlin Mine
Earthquake in Malay, 1859
Earth and Life Through Time, A Book Review
Asian Mining '88
Earthquake History of California
Watersheds Mapping in Northern California
Gold Deposits, Pacific Ocean Island
Geologic Saga of Iceland
Preliminary Special Studies Zones Maps
DMG Reclamation Program
NEWT System
Geology and Slope Stability, Fort Bragg Area
Debris Avalanches

Mexico Earthquake Damage
Mexico Earthquake Record
Destructive Mexico Earthquake
AGU Meeting Extracts
Ocean Floor Research (EEZ)
California Earthquake-Hazard Laws
Careers in Geoscience: Geologist and Earth Science Teacher
Mineral Industry of California, 1985
Stampmill Demonstration
Selenium
Asbestos Mining
Cretaceous Amphibole-Rich Gabbros
Northern California Storms
Mount Dana Photo Essay
Nonfuel Mineral Resources
Rancho La Brea: A Look at Coastal Southern California's Past
Geologic Recommendations for Timber Harvesting
Geologic Overview of Xinjiang
Limestone Mining

c. Open-File Reports

The DMG open-file report series consists of reports and maps that present reliable geological information in a relatively unpolished form, generally as copies of a typescript text and ozalid maps. Information is released in this way in order to make it available to users in the shortest possible time or because the nature of the information does not warrant more formal publication.

DMG open-file reports and maps are available for reference at the information sections of the Los Angeles, San Francisco Bay area, and Sacramento offices. Unless otherwise announced, an open-file report (OFR) can be purchased (at cost of reproduction) through the DMG office that has the OFR on file. The office that has any particular OFR on file is indicated by the final letters of the publication's number, as follows: LA (Los Angeles Office); SF (San Francisco Bay area office); and SAC (Sacramento Office).

OFR 85-7 LA. Mineral Land Classification of the Ivanpah-Crescent Peak-Searchlight 15-Minute Quadrangles, San Bernardino County, California. Stephen E. Joseph, Scale 1:62,500. This report presents the results of the Division of Mines and geology's mineral land classification study of the Ivanpah, Crescent Peak, and Searchlight 15-minute quadrangles, which consists of 405 square miles of land in the eastern Mojave Desert. The data for classification were obtained from original field observations of mineral deposits and geologic units, and from published and unpublished reports concerning the geology and mineral deposits of the area. Results of this study indicate that in addition to gold, clay, limestone, and sericite, which are currently being mined within the Ivanpah-Crescent Peak-Searchlight quadrangles, geologic environments favorable for the occurrence of rare-earth elements, perlite, fluorite, molybdenum, lead, zinc, silver, tungsten, copper and magnesite exist.

OFR 85-12 SAC. Monitoring Geothermal Wells and Spring Conditions in Selected Areas of California for Earthquake Precursors. Stephen P. Bezore. This report presents the results of a nine-month geothermal earthquake-precursor monitoring project conducted in the Long Valley Caldera near Mammoth Lakes, California. Seven geothermal sites in the Caldera were monitored from July 1982 through March 1983, a period during which earthquakes occurred in the area.

OFR 85-13 LA. Mineral Land Classification of the Pleuss-Staufer, Inc., White Knob Limestone Deposit, Lucerne Valley, San Bernardino County, California. Stephen E. Joseph, Scale 1:24,000.

OFR 85-14 SAC. Complete Bouguer Gravity and Aeromagnetic Maps with Geology and Thermal Wells and Springs of the Santa Rosa-Sonoma Area, Sonoma and Napa counties, California. Rodger H. Chapman, Scale 1:48,000. The report is a compilation of selected geophysical data from several California Department of Conservation, Division of Mines and Geology geothermal resource investigations in the Santa Rosa-Sonoma area, Sonoma and Napa counties, California. The report includes a complete Bouguer gravity map and an aeromagnetic map of the Santa Rosa, Kenwood, Rutherford, Cotati, Glen Ellen, and Sonoma U.S. Geological Survey 7.5-minute topographic quadrangle maps at a scale of 1:48,000. The geophysical data are overlain on a compiled geologic map. Also included on the maps are annotated locations of warm water wells and springs (having a water temperature of 20°C [68°F] or greater) and locations of exploratory and production petroleum wells in the area. Table 1 of the report contains physical data on the posted wells and springs including water temperature and well depth, if known.

OFR 85-17 LA. Mineral Land Classification of the United States Tile Co., Dominguez Clay/Shale deposit, Corona, Riverside County, California. Stephen E. Joseph, Scale 1:12,000.

OFR 85-19 LA. Geothermal Systems of the Mono Basin-Long Valley Region, Eastern California and Western Nevada. Chris T. Higgins. Scale 1:125,000. This report presents the results of a cooperative study of geothermal systems in the region from Aurora, Nevada, and Bridgeport, California, south to Long Valley, California, by the Division of Mines and Geology and the Division of Earth Sciences of the University of Nevada, Las Vegas. The study, the initial reconnaissance phase of a project that was proposed to span several years, interprets a wide range of geodata in an effort to understand the orogeny and structure of the region and to identify anomalies significant for the understanding of its geothermal systems.

OFR 85-20 SAC. Aeromagnetic Map of the San Bernardino 1-degree by 2-degree Sheet, California. Leslie G. Youngs. Scale 1:250,000.

OFR 85-21 SAC. Aeromagnetic Map of the Weed 1-degree by 2-degree Sheet, California. Gordon W. Chase. Scale 1:250,000.

OFR 85-22 SAC. Mineral Land Classifcation of the W.L. Harvey Clay/Shale Deposit, Placer County, California. Gary Taylor. Scale 1:24,000.

OFR 86-3 SF. Summary Report -- Fault Evaluation Program 1984-85, Southern Coast Ranges Region and Other Areas. Earl W. Hart. Scale 1:24,000.

OFR 86-6 LA. Landslide Hazards in the West Half of the Newhall Quadrangle, Los Angeles County, California. Jerome A. Treiman, Scale 1:24,000. This set of four maps (printed on two sheets) constitutes Landslide Hazard Identification Map #2. The maps, prepared under the Landslide Hazard Identification Program, are intended to provide information about slope stability for use by local officials in land-use planning and evaluation of building permit applications. The maps (at a scale of 1 inch equals 2,000 feet) consist of: Plate 2A1 -- Relative Landslide Susceptibility; Plate 2A1 -- Relative Debris-Flow Susceptibility; Plate 2B -- Landslides and Related Features; and Plate 2C -- Geologic Map.

OFR 86-9 LA. Landslide Hazards in the East Half of the Val Verde Quadrangle, Los Angeles County, California. Allan G. Barrows, Scale 1:24,000. This set of four maps (printed on two sheets) constitutes Landslide Hazard Identification Map #5. The maps, prepared under the Landslide Hazard Identification Program, are intended to provide information about slope stability for use by local officials in land-use planning and evaluation of building permit applications. The maps (at a scale of 1 inch equals 2,000 feet consist of: Plate 5A1 -- Relative Landslide Susceptibility; Plate 5A2 -- Relative Debris-Flow Susceptiblity; Plate 5B -- Landslides and Related Features; and Plate 5C -- Geologic Map.

OFR 86-11 SAC. Detailed Ground Magnetic Survey of a portion of the Odd Fellows Lawn Cemetery, Sacramento, California. By L.G. Youngs, and A.A. Hill. 1985. The report presents the results and interpretations of data from a detailed ground magnetometer survey of a 50 x 50 foot plot of ground in the Odd Fellows Lawn Cemetery, Sacramento, California. The study was done as a demonstration project for staff of the California Department of Justice, Bureau of Organized crime and Criminal Intelligence. The purpose of the project was to demonstrate the feasibility of using a portable proton magnetometer to locate possible unmarked graves.

THIS BOOK IS DUE ON THE LAST DATE
STAMPED BELOW

BOOKS REQUESTED BY ANOTHER BORROWER
ARE SUBJECT TO IMMEDIATE RECALL

REFILED PSL
APR 6 19
MAY 12 1990

MAY 2 1990 REC'D
RECEIVED
MAY 03 1990
PHY SCI LIBRARY

LIBRARY, UNIVERSITY OF CALIFORNIA, DAVIS
Book Slip–Series 458

SEVENTY-EIGHTH REPORT OF THE STATE GEOLOGIST (1985-1986)